Materials & Methods

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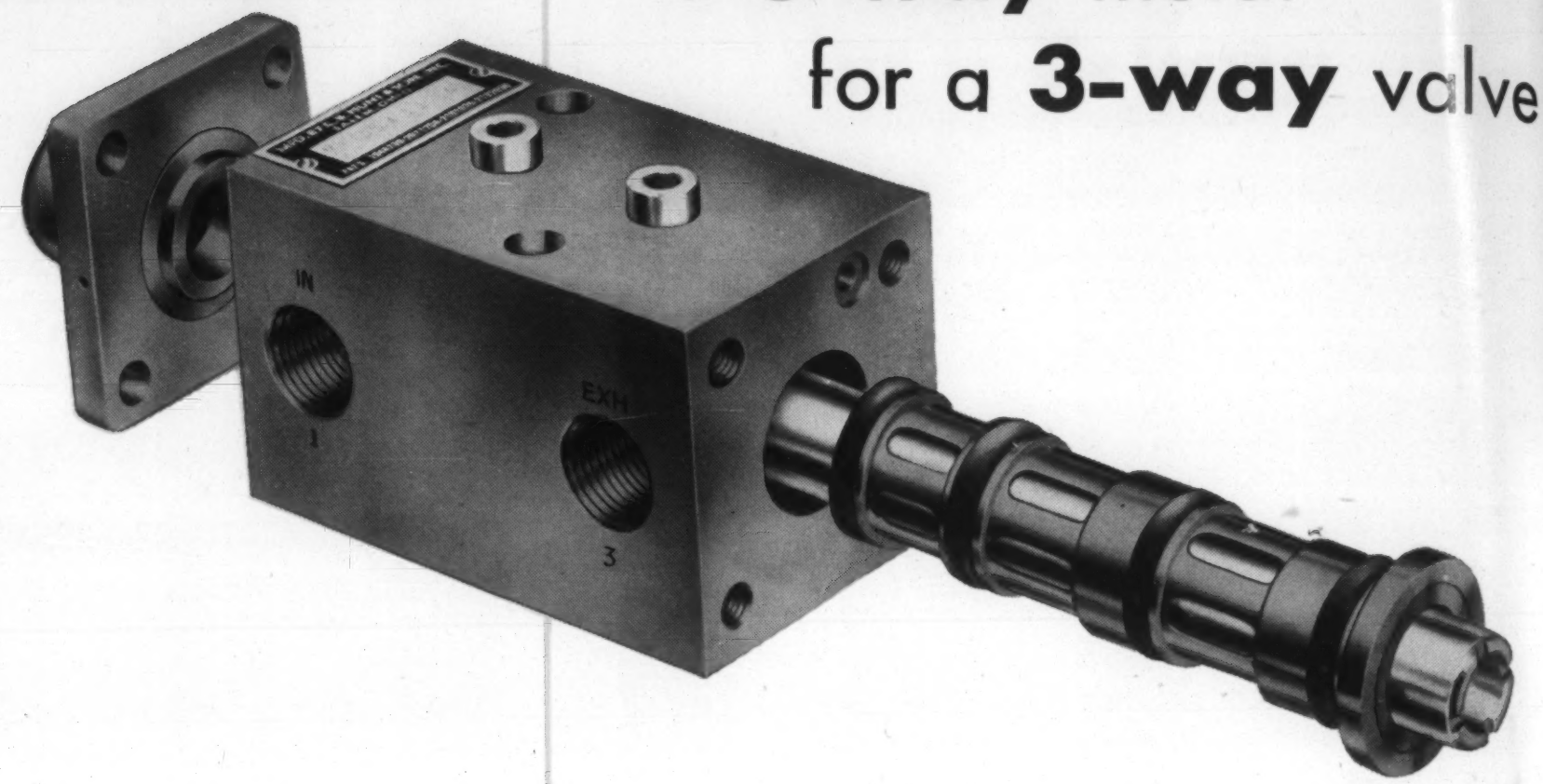
DECEMBER
1952

THE MAGAZINE OF

MATERIALS ENGINEERING

DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

a **3-way** metal for a **3-way** valve



This is a "3-way" solenoid-pilot-operated control valve, made by C. B. Hunt & Son, Inc., used for operating large pneumatic and hydraulic industrial equipment. After thorough consideration by Hunt's engineering department, with an "assist" or two from The American Brass Company, ANACONDA Free Cutting Brass-271 was chosen for the 2½ in. x 2½ in. wrought bar stock used for the body. Here's what was required:

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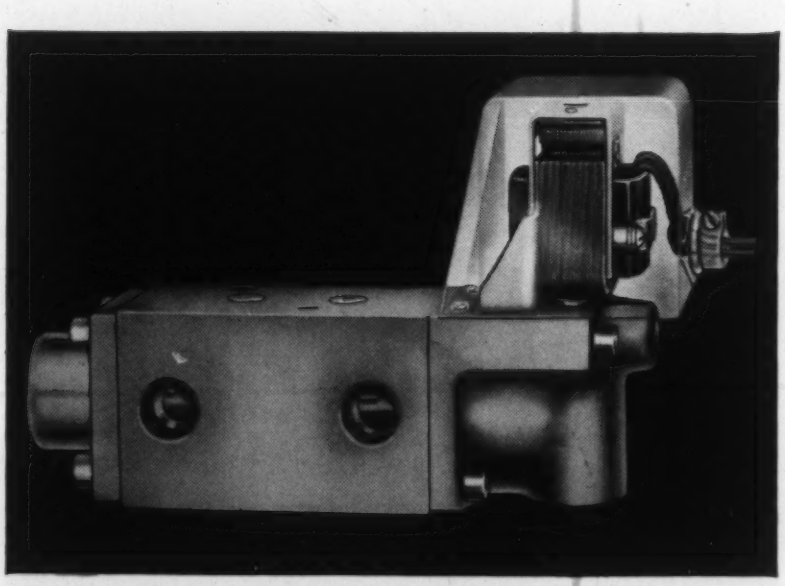
3. **READY MACHINABILITY** — to economically perform a multitude of drilling, reaming, tapping and milling operations.

For the same reasons, ANACONDA Extruded Brass Rod of the same composition was used for the packing spacers, and ANACONDA Brass Die Pressed Forgings for the pilot caps.

Maybe we can help you in matters of design or production where copper and copper alloys are concerned. Write The American Brass Company, General Offices, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario, Canada. 5296



This Type SA3 "3-Way" Solenoid-Pilot-Operated Valve for control of single acting cylinders is one of a complete line of "Quick-as-Wink" Control Valves made by C. B. Hunt & Son, Inc., Salem, Ohio. (When the solenoid is energized, the controlled single-acting piston moves to the extreme limit of its travel and remains there until the solenoid is de-energized, permitting the piston to return to its original position.) The design of the valve combines all the advantages of single-plunger construction with a new operating means for electrical control.

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Feature Articles

• Which Method to Evaluate Surface Roughness? . . . . . *Irwin Goldman* **89**
Methods now available take much of the guesswork out of specifying surface finish

• Titanium and Zirconium Castings Now Practicable . . . . . *W. E. Kuhn* **94**
New development to be exploited for permanent mold castings and precision castings

• Aluminum Honeycomb Sandwich Material . . . . . *Philip O'Keefe* **96**
Boasts light weight, high strength, good dimensional stability, and uniform density

• Laminated Plastics Improve Bearing Performance . . . . . *Herbert Widdop* **99**
Cotton fabric phenolics eminently suited for precision bearings operating at high speed

• Spun and Drawn Zinc Parts Have Many Applications . . . . *Ernest B. Gent* **102**
These little known forms offer many advantages to engineers and designers.

• Aluminum Coatings Applied to Steel by Many Methods . . . . . *E. M. Smith* **105**
Wide range of finish characteristics available to meet many different service conditions

• Versatile Fixtures for High Production Gas Carburizing . . . . *T. A. Frischman* **109**
Their use results in high quality treated parts that meet close tolerances

• Materials at Work **112**
New, unique applications of new and old engineering materials

• Brazing Vacuum-Tight Joints in High Nickel Alloys . *Robert A. Wallace & William R. Vanderveer* **117**
How clean, oxide-free brazes were obtained on large Inconel parts

• Aluminum Film Cans Automatically Formed and Finished . . . . *Stephen M. Tucker* **168**
Many forming and finishing operations revamped to lower production costs

• The New "Materials Show" **9**
A message from the Publisher of Materials & Methods

Materials & Methods Manual No. 89

Aluminum Bronze . . . . . *John L. Everhart* **119**

Engineering File Facts

Limiting Creep and Stress Rupture Values for Alloys in Sheet Form (No. 240) **139**

Semi-Annual Index to Feature Material, Volume 36 263

Departments

The Materials Outlook **3**
Materials Control Orders . . . **6**
News Digest **9**
New Materials & Equipment . . **145**
Meetings and Expositions . . **234**
Book Reviews **236**
Manufacturers' Literature . . **251**
Advertisers and Their Agencies . **266**
The Editor's Page **268**

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The Materials Outlook

Aluminum-copper-cadmium alloy in heat treated condition has properties at least equal to Duralumin, but shows remarkable facility for hot working and does not age at room temperature after solution treatment. The new alloy can be fabricated cheaper and faster than Duralumin.

Iron core, copper-plated, tin-coated capacitor leads save copper. New leads are equal to or better than standard tinned copperplate wire in tensile strength, elongation, resistance to bending and twisting and ease of soldering. Electrical resistance is twice that of standard tinned-copper wire.

Air-cooled welding torch saves time in changing electrodes and makes it unnecessary to disconnect gas and power lines. It is small and light, constructed of insulating fiber and copper tubing. Switch from 105 to 180-deg electrode angle is made quickly by attaching angular tip to simple threaded connection.

American executive reports on European machine tools. European product is beautifully finished, but underpowered by our standards. American tools are at a price disadvantage, however. One pound of cast iron for machine tools cost 21¢ in U. S., 14 to 15¢ on the continent and 10¢ in England.

Welding procedures have been developed for titanium, including practical information on groove design, welding sequence, method of bead deposition and direction of welding forehand and backhand. Inert gas tungsten arc process was used, and comparisons were made between helium and argon gas for shielding.

Hot rolled magnesium alloy plate price has been reduced by one supplier. Plate 3/16 in. and heavier is being offered at a price competitive per sq ft with aluminum. The cut amounts to more than 20%.

Preheat at 400 F is as effective as 1200 F stress relief heat treatment in improving performance of low carbon steel weldments made with AWS type E6010 electrodes for static and impact loading, according to seven independent investigations. A change in codes to permit this substitution would permit more extensive use of welding. . . . Preliminary studies indicate preheat may not be as effective for fatigue loadings.

(Continued on page 4)

The Materials Outlook *(continued)*

"Titanium–the New Metal" is title of Bureau of Ships Journal article describing development, present production, fabrication methods and problems. Listed: composition, designation and source of commercial titanium and alloys, nominal mechanical and physical properties of each. The article also makes comparative analysis of titanium, aluminum, stainless steel and other structural metals, and discusses the Navy program for utilization of this metal.

Electroluminescence, the illumination of a phosphate-coated glass panel under an electromagnetic field, is being explored by a lamp manufacturer. As a commercial light source, it is still a possibility. Under ordinary conditions, electroluminescence produces only a small amount of light at very low efficiencies.

Vinyl-metal sandwich has been developed. Thin metal sheets are cleaned, dipped in adhesive solution, then put through rolls to get vinyl layer on one or both sides. Chemical and decorative uses are expected. The sheets can be bent and folded without breaking coating.

New spot and projection welder uses magnetic force of welding current to produce rapidly rising pressure on work. The pressure is adjustable and perfectly synchronized with welding current. Work has been done on copper, silver, brass, tungsten, aluminum and steel.

Pure silicon is now commercially available. It is being investigated for use in transistors. Silicon is cheaper than germanium.

New developments in magnesium castings are coming fast. The largest magnesium sand casting ever made was displayed at the Metals Show by Rolle Manufacturing Co. This is a production radar part. Magnesium investment castings are also being made. Thin-walled airframe castings are another frontier. Shell molding has been used experimentally with the light metal.

High strength flux-free brazed bonds between steels and corrosion resistant alloys has been developed. Uniform strengths over wide areas are produced. Flux entrapment, oxide formation and entry of foreign materials into the bonding zone are avoided. No flux or atmosphere is required in the furnace with the vacuum techniques used. One application is in making clad steel cheaper, with better finish, less waste and less expensive equipment than by conventional rolling.

Titanium 100A (oxygen-nitrogen alloy) spot-welds easily. Recent paper shows effects of weld time, weld current, tip pressure and tip shape on weld penetration, indentation, weld strength and hardness.

(Continued on page 6)

THE NEW "MATERIALS SHOW"

A Message from the Publisher

As publisher of MATERIALS & METHODS, it is my pleasure as well as my duty to call your attention to—and enlist your support of—the "First Exposition of Basic Materials for Industry", the details of which were recently announced. The "Materials Show", as it probably will be known, will be held at Grand Central Palace, New York, June 15-19, 1953. In addition to the exhibits of materials, parts and finishes, technical conferences are being scheduled to discuss and explore the broad materials problems of industry in order to further the intelligent selection and application of engineering materials.

The Materials Show is to be operated by the extremely capable exposition management firm of Clapp & Poliak, Inc., and is to be guided by a sponsoring committee composed of representative leaders of American industry. Clapp & Poliak, Inc. manages many trade and industrial shows, including the National Plastics Exposition and the Machine Tool Show, and has a successful background for this undertaking.

The sponsoring committee is headed by Mr. Don G. Mitchell, President, Sylvania Electric Products, Inc. We congratulate Mr. Mitchell and his committee for their foresightedness and we offer the services of our staff to his committee. Among companies represented on the sponsoring committee are: American Lava Corp., Beryllium Corp., Bridgeport Brass Co., Corning Glass Works, Gamble Brothers Inc., B. F. Goodrich Chemical Co., Metal Hydrides Inc., Mica Insulator Co., Mt. Vernon-Woodberry Mills, Norton Co., Powdered Metal Products Corp. of America, Reynolds Metals Co., Sponge Rubber Products Co., Star Porcelain Co., Superior Steel Corp., United States Plywood Corp., and others.

One of the reasons for our enthusiastic support of the Materials Show is that here for the first time, under one roof, the users of materials will find examples of all major industrial engineering materials. There is today such a strong interrelationship between the various materials used in product design and manufacture that it is only logical they should be shown together in one place, and not dispersed among different shows as has been the case up to the present time. Engineers should welcome this opportunity to see, compare and appraise all the major engineering materials at one time and at one location.

Obviously our enthusiasm for the Materials Show is enhanced by the fact that the aims and objectives of the show parallel so closely the editorial aims and objectives of this publication. For many years MATERIALS & METHODS has been doing in two dimensions on the printed page what the Materials Show will do in three dimensions. We urge our advertisers and prospective advertisers to investigate and seriously consider taking space in order to exhibit their products. As tangible evidence of our own support, we have already arranged for a prominent booth. In addition, our June 1953 issue will be largely devoted to the Exposition and its exhibits.

We have been assured that exhibits in the show will be restricted to those of companies producing and fabricating engineering materials used in product design and manufacture. The Materials Show will not be cluttered up with exhibits of fringe products that have no bearing on basic materials engineering problems.

Again we urge our subscribers and readers to plan to attend the Show, and our advertisers and prospective advertisers to reserve space for their exhibits.

William P. Winsor
Publisher

First Exposition of Materials for Industry Announced for June

All Engineering Materials to Be Exhibited. Conference Sessions for Users Scheduled

The First Exposition of Basic Materials for Industry will be held in Grand Central Palace, New York City, during the week of June 15th to 19th, 1953. Under one roof, and at one time, all the significant materials used in product manufacture will be brought together in the first exposition of its kind in this country. Metals, alloys, plastics, leathers, woods, ceramics, textiles, rubber, cork and glass will be shown.

The show will draw technical and management of all kinds, including engineers, design engineers, designers, project engineers, production men, materials engineers, research men, marketing executives and technical and top management personnel. They will have a chance to examine and compare materials first hand, and to talk with technical men from the supplier companies.

The conference sessions will be aimed at the materials users. They will cover the problems of materials selection and application, and will attempt to give the kind of information most sought by materials users. The emphasis will be put on comparative performance, testing, applications, as well as the impact of fabrication methods on materials choices.

The Chairman of the Board of Sponsors is Don G. Mitchell, president, Sylvania Electric Products, Inc. Other sponsors include: P. P. Alexander, president, Metal Hydrides, Inc.; George L. Bachner, president, Powdered Metal Products Corp. of America; Thomas M. Bancroft, president, Mt. Vernon-Woodberry Mills; Carl I. Collins, president, Superior Steel Corp.; M. A. Chapman, president, Mica Insulator Co.; F. M. Daley, president, The Sponge Rubber Products Co.; M. J. Donachie, president, The Berryllium Corp.; and Cornelius D. Dosker, president, Gamble Brothers, Inc.

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The exposition of Basic Materials for Industry, and its concurrent conference, is sponsored by the industrial exposition management firm of Clapp & Poliak, Inc., New York. Among the expositions the company manages are the Machine Tool Show, the National Materials Handling Exposition, the AMS National Packaging Exposition, the International Beverage Exposition, the International Brewing Industries Exposition, the Confectionery Industries Exposition, The National Plastics Exposition, and the Plant Maintenance Show.

See preceding page for message from publisher on the Materials Show.

Titanium Is Main Attraction at Metals Show

The great interest in titanium which has been aroused by the continuing publicity given to this material was apparent at the National Metal Congress held in Philadelphia during the week of Oct. 20.

The Institute of Metals Div. of the AIME sponsored an off-the-record symposium on titanium under the joint chairmanship of M. A. Hunter of Renssalaer and J. R. Long of the Minerals and Metals Advisory Board, which drew overflow crowds to the Crystal Room of the Adelphia. Attendance was estimated at 600 at each of the two sessions.

Hunter led off with an interesting discussion of the early history of titanium, and he was followed by Long, who reviewed the Bureau of Mines developments which preceded commercial production. The significance of titanium in the defense program was discussed by Col. Dick of

Chrysler is now press forging steel crankshafts on a mechanized production line. This work was previously drop forged. The change increased production of a single line 2 to 30 times and cut labor costs by automation.

the Air Forces, Col. Mesick of the Army and Mr. Beardman of the Navy. New processes for production and fabrication, discussed by R. S. Dean and G. S. Davis, concluded the morning session. The afternoon session was devoted to a discussion of the present status of titanium by seven men active in the field.

Although the symposium was off-the-record, some of the papers have been released and will be published in the *Journal of Metals*. One of these, Col. Dick's, is particularly significant, for it indicates the extent to which the Government is promoting the development of titanium.

Col. Dick announced that the Defense Materials Procurement Agency is currently sponsoring an expansion program for the production of titanium which will represent a possible expenditure of $150,000,000. Expansion contracts are now in effect with two organizations, and it is anticipated that additional contracts will be awarded in the near future. He noted that the greatest problem facing the industry at present is that of producing consistently high quality materials in the quantity required and on a regular schedule. It might be noted that this has been one of the major problems faced by the industry since the beginning of commercial production. Col. Dick suggested that greater progress in attaining this goal could be expected if it were possible to arrange for an exchange of technical alloying information through the cooperation of the Government and the producers.

He stated that at present production development for the aircraft industry includes applications in spacers, rings, blading, and other compressor parts in jet engines in addition to firewalls, nacelles, fuselage structure, shrouding and other stress-bearing members in airframes, and noted that because of the weight advantage offered by titanium, practically every aircraft part has been considered for design in this material. The Air Force has recently authorized Convair to incorporate titanium in production quantities on the B-36 airframe. Col. Dick revealed further that the Munitions Board has started to organize a Committee of high-ranking officers in the Defense Dept. to expedite the development and use of titanium.

C. B. Voldrich chose "The Welding and Brazing of Titanium Alloys" as his subject in presenting the Adams Lecture to the American Welding Society, and spoke to a crowd which overflowed the meeting room. Six other papers on the problems encountered in the welding of titanium were also delivered to large audiences.

Among other interesting developments in the field were the exhibition of a 2-ton ingot of titanium and a coil of titanium strip 3 ft wide, 0.015 in. thick and 400 ft long by Rem-Cru.

Properties of High-Impact Polystyrene Discussed

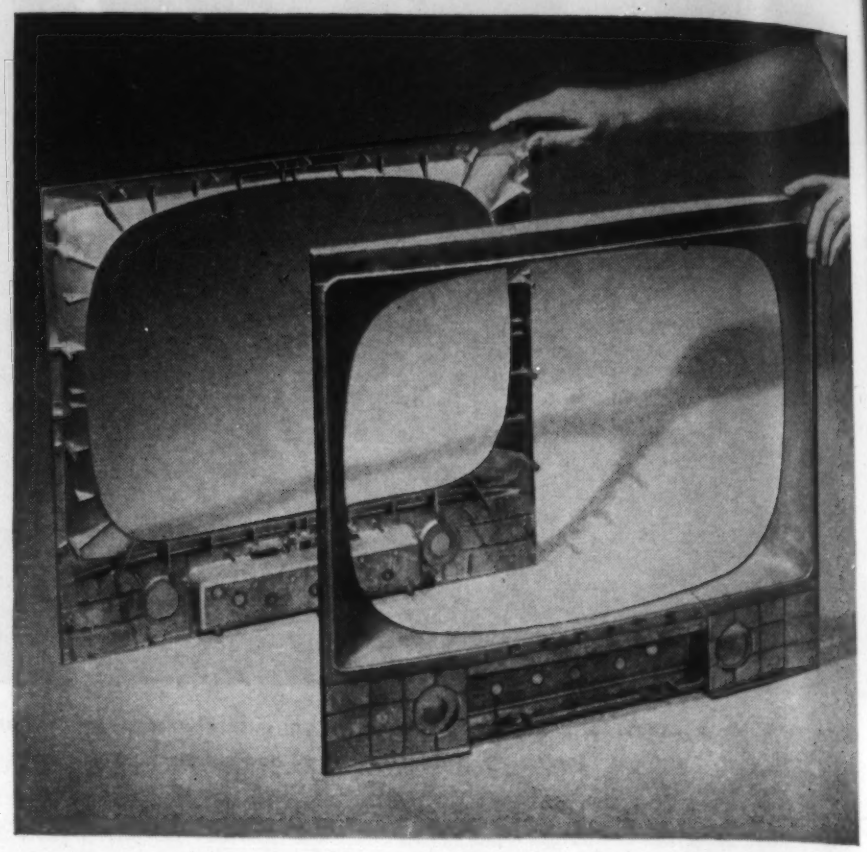
The range of properties available in regular and high-impact polystyrenes was emphasized by Charles J. Snyder of Koppers Co., Inc., in an address before the New England section of The Society of the Plastics Industry recently.

"Too much emphasis has been placed on the single laboratory value termed *impact strength*, which is merely a measure of the force required to break one body against another. This does not show the resistance to stretch, the elasticity, the wear resistance, the heat resistance, the cold flow, or the dimensional stability of a molded part. Impact strength is but one property and cannot by itself characterize a material. Hence the term *high impact polystyrene* is misleading and universally misinterpreted.

"When a molder, designer or end user obtains a property data sheet, he invariably looks at the Izod or Charpy impact strength value and decides that a material is tough or not simply by the numerical value of that one test. One cannot honestly use impact strength values alone to determine material strength for proper design.

"One of the most significant set of test values is that of tensile strength, elongation in tension, and modulus

(Continued on page 13)



get the mo$t for your Zinc Die Ca$ting Dollar!

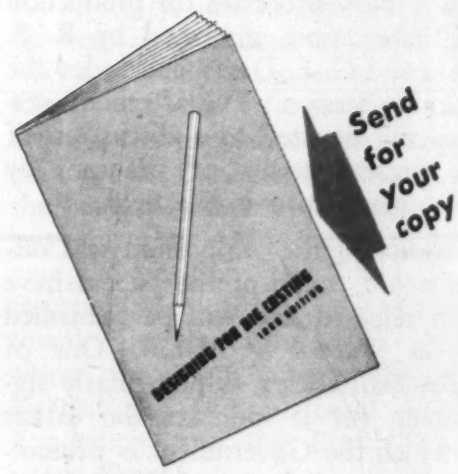
The combination screen and control panel escutcheon for the latest Zenith 21-inch television receiver—shown from both sides above—embodies most of the design and production advantages offered by ZINC Die Casting. How else could the escutcheon have been produced at comparable cost? Consider these details:

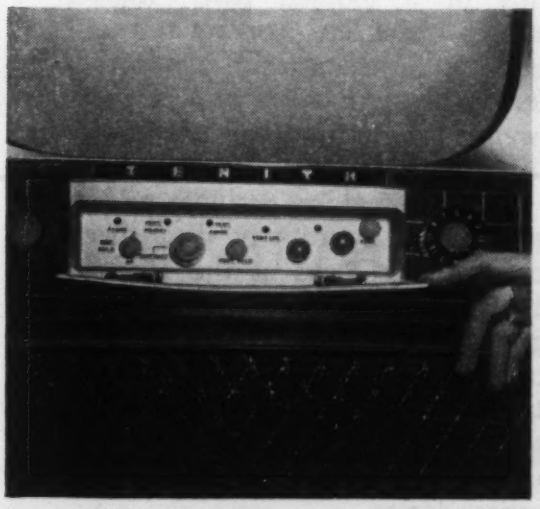
1. Many machining and assembling operations are avoided since all projections, recesses and openings are cast or cored with a high degree of dimensional accuracy in the die casting operation.

2. Cost is further minimized by the high speed at which the ZINC Alloy is cast in a hot chamber die casting machine.

3. Section thicknesses are kept at a minimum to conserve both metal and weight (note the strengthening ribs in the rear view) and there is no scrap loss.

4. Not only are decorative effects faithfully reproduced on the face of the escutcheon, but raised lettering is cast with clean-cut detail (see engraving in the recess behind the control panel door at the left below). The smooth cast surfaces permit low cost finishing with modern organic coatings to provide a gold plated appearance.





GET DESIGN DATA EARLY

The surest way to realize the full physical and economic advantages of ZINC Die Castings is through consultation with a competent die casting engineer in the *early* design stages. Ask any die casting company for help and ask them—or us—for a copy of "Designing For Die Casting."

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FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on

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News Digest

continued from page 11

of elasticity. The tensile strength is the fiber stress of a material in a molded part, and by a few simple calculations using the modulus of elasticity and the elongation, a curve can be drawn which shows the work a material can do. This is a measure of its toughness. As the modulus of elasticity of a material increases, more rigid products are obtained. As it decreases, more flexible or elastic ones are obtained.

"Polystyrene is a fairly brittle rigid material. The values of Izod impact strength and elongation are low, indicating lack of extremely high strength and little elasticity. On the other hand, the tensile strength values and modulus of elasticity indicate that the molded product is well bonded together, but is fairly brittle. Furthermore, the low moisture absorption shows good dimensional stability characteristics, and the hardness value indicates low abrasion resistance.

"Passing to the *medium impact* materials, the same test values show that products made from these polystyrenes will take more shock because of greater elasticity. More stretching and less sustained force will be required to rupture the product. In these medium impact polystyrenes, the moisture absorption is still low and the hardness values are about equal to regular polystyrene. Thus, dimensional stability and abrasion resistance will be nearly the same as for polystyrene.

"The values for *high impact* materials indicate that a very ductile molded product will result which will have more shock resistance than can be obtained using the two previously discussed types of materials. However, decreased tensile strength values indicate that an even lower sustained force will be necessary to bring about rupture of the part than would be found with regular or "medium impact" styrenes. Moisture absorption is slightly increased over the value for regular polystyrene. This value is not serious enough to cause a marked decrease in dimensional stability, and is considerably lower than for other thermoplastics. The hardness value is very low and actual experience shows that products made from the high impact materials

(Continued on page 174)

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HOW TO
SPEED PRODUCTION
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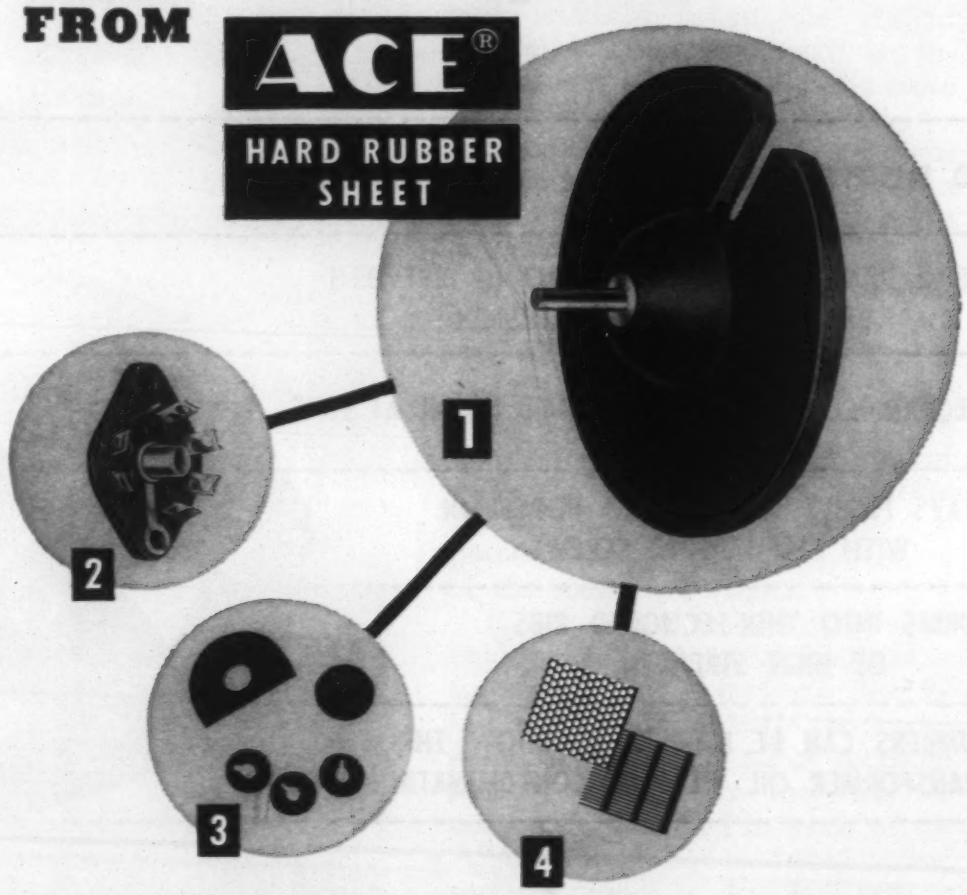

IDEA 1 Cut from strong, wear-resistant ACE hard rubber sheet, this precision-machined meter piston spends years under water without warping or swelling.

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STAYS FIRMLY FASTENED TO PORCELAIN WITH SELF-TAPPING SCREWS

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You name it— we'll make it— and fabricate it, too.

IN DUROID 700 Westinghouse found a fibrous material that provided a vastly improved support for the tap changer in one of its distribution units. Listed by Underwriters Laboratories, this Duroid is one of many specially processed fibrous materials developed by Rogers. Several steps above conventional fibrous products, it combines rigidity and firmness with non-brittleness. In its ability to outperform standard non-metallic sheet materials in its class, Duroid 700 typifies the special work Rogers is doing with fibrous sheet products. Rogers may have—or can develop—just the material you need to effect a design improvement. We will not only provide the material, but fabricate finished parts as well.

CATALOG Complete data about DUROID 700 and other Rogers Duroids are available. Please write to Dept. M, Rogers Corporation, Manchester, Conn.

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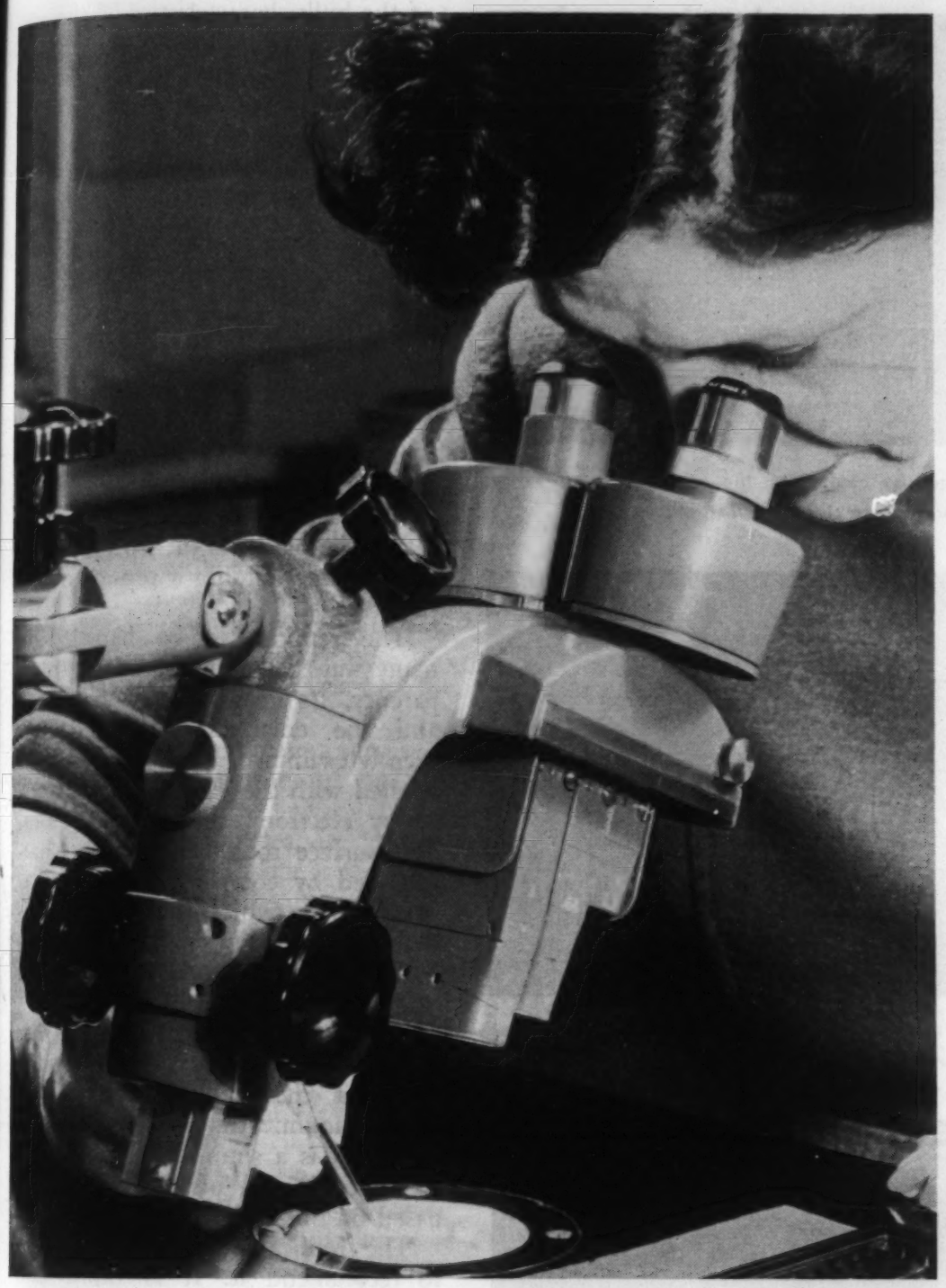


BINOCULAR MICROSCOPE is the most generally useful method of characterizing surface roughness.

Which Method to Evaluate Surface Roughness?

A number of accepted surface finish standards and measuring methods are now available. They are taking much of the guesswork out of the difficult question "How smooth is the surface?"

by **IRWIN GOLDMAN,** Physics Laboratories, Sylvania Electric Products, Inc.

● IN THE DESIGN and manufacture of products, it is often important to describe the roughness of a surface. While in many cases it is sufficient merely to make the surface "unsmooth" and experienced personnel will recognize when the desired degree of "unsmoothness" is obtained, it is often found that a more quantitative measure is called for.

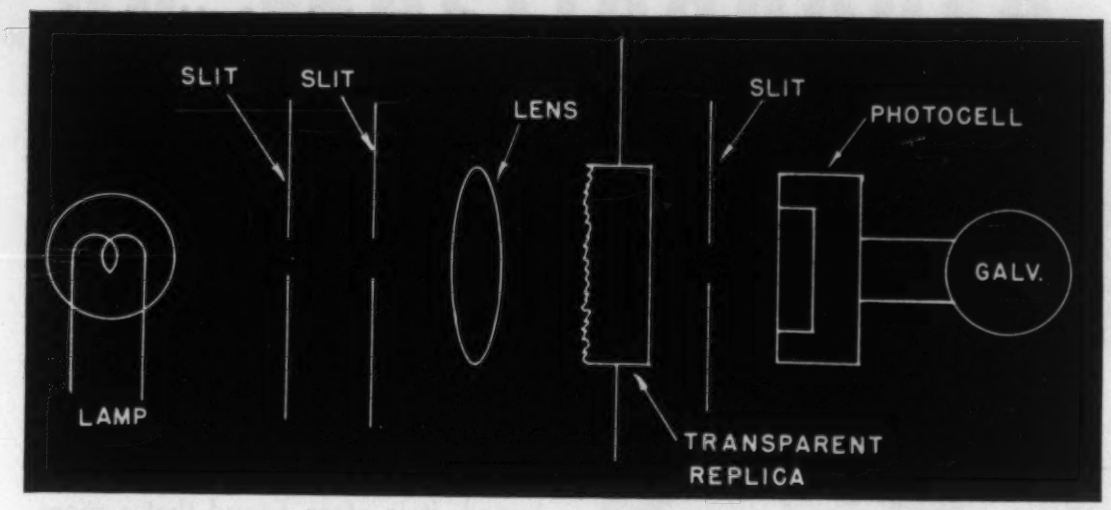
Some years ago, the American Standards Association established a committee to set up standards for the designation and classification of surface roughness. However, the work of this committee to date has not resulted in any general description of surface character. The standard issued by this committee deals with the height, width and direction of surface irregularities, but does not concern itself with the shape, appearance or method of measurement of the roughened surface.

It is possible to recognize quite readily the complications involved in successfully and completely describing a surface. Uniformly roughened surfaces present no major measurement problem since they can be adequately described in terms of the ASA standard. But randomly, etched surfaces cannot be described only in these terms. One must be concerned with such additional details as: (1) the total surface area; (2) the degree of undercutting of the surface; (3) the shapes of the peaks and valleys comprising the surface; (4) the proportion of the surface area which lies parallel to the surface plane; (5) the degree of uniformity of the etched pattern, and other such intimate details which concern the character of the surface.

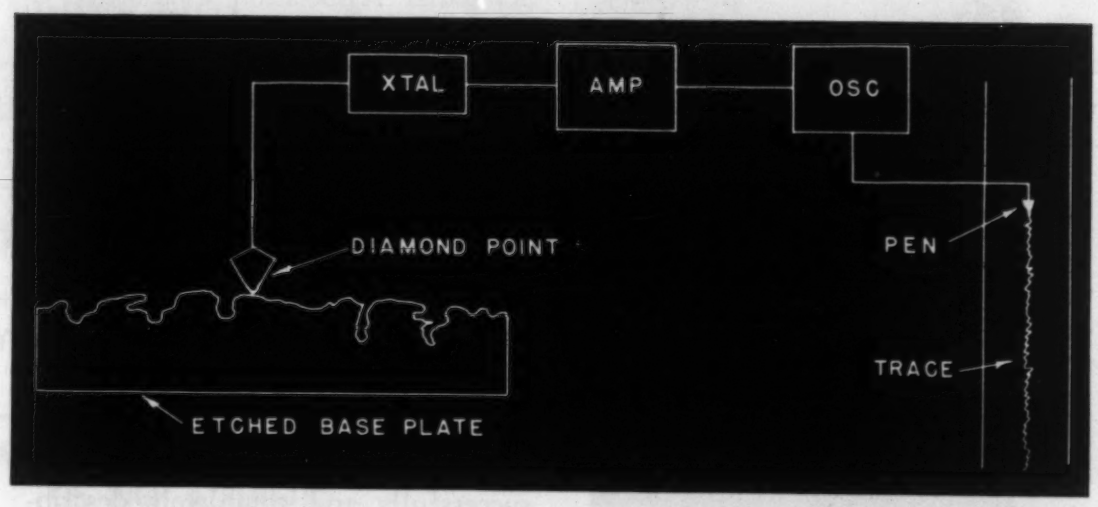
All of the items listed above need not be significant. This will depend on the application for which the information is sought. The methods of characterization described below differ in the amount and type of information which they reveal. The particular problem should indicate which of the methods or combination of methods will be most useful.

Photomicrographs

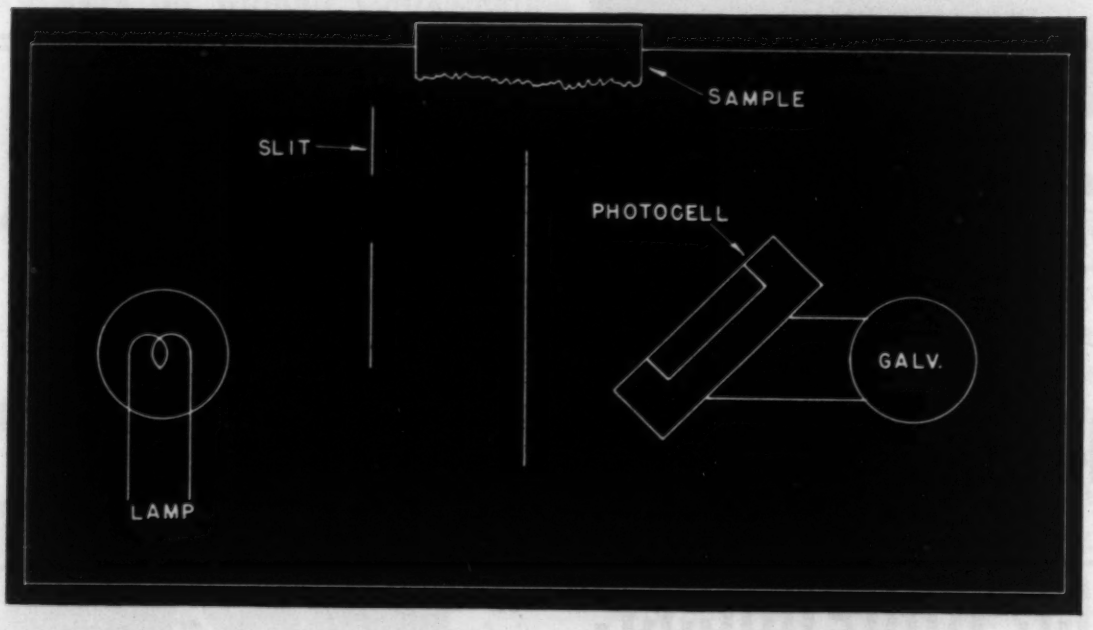
A photomicrograph of the cross section of the surface produces a clear, readily understood representa-



***PLASTIC REPLICA METHOD** characterizes a surface by comparing the scattering of light by a plastic replica with that produced by a clear plastic film.*



***SURFACE ANALYZERS** operate essentially as shown in this schematic diagram. Numerical value can be obtained on a meter, or a trace made of results as shown.*



***REFLECTION METHODS** determine surface roughness by use of a simple light box, design of which is shown here.*

tion of the surface profile; measurements of the "peak to peak distance" and the "peak to valley depth" are easy to obtain. Furthermore, the photomicrographs provide readily available permanent records of the surface.

However, the method has several serious disadvantages. It is, first of all, time consuming and expensive to prepare the photomicrographs. It is likewise tedious to make accurate measurements of the surface characteristics. Of major concern is the fact that the area examined is very small and may not be representative of the bulk characteristics of the surface. Finally, the samples must be cut for mounting and thereby destroyed, making them unavailable for further study.

Plastic Replicas

A useful technique for the study of surface characteristics is the transparent plastic replica. There are several commercially available kits all of which are based on substantially the same principle—that of wetting the surface to be examined with a solvent for the transparent plastic and pressing the plastic to the surface until the solvent evaporates. The plastic is then peeled from the surface, yielding a replica of the pattern.

The replica can be handled in many ways to capitalize on its transparency. Its image can be projected and the enlarged version conveniently examined. The replica can be studied with the electron microscope or by electron diffraction methods. The surface roughness can be characterized by comparing the amount of scattering which this replica produces in a beam of light as compared with that produced by a clear film of plastic.

The last method mentioned has been used with some success in the study of chemically etched surface of aluminum. An accompanying illustration is a simplified diagram of the optical path of the instrument based on this technique.

The replica technique has much to recommend it. It is rapid and economical. The cost of materials is less than 1¢ per replica. A permanent record of the surface is obtained by nondestructive means. The replica reproduces a large area (about 1 sq cm) of the surface and it is possible, using the light scattering technique, to obtain a single numerical value to characterize the surface.

Some caution is necessary when applying this method to highly random rough surfaces. Our experience has indicated some lack of reproducibility and sensitivity. This latter feature is important when it is desired to distinguish between surfaces which differ in minor features that may be important in the ultimate application.

Surface Analyzers

Surface analysers use a diamond tracer point which travels over the surface of the specimen. The vibra-

tions of the diamond point are fed to a piezoelectric crystal whose amplified output actuates a stylus point which, in turn, yields a written record of the surface roughness on a moving chart. The accompanying figure is a simplified schematic diagram of the instrument.

These charts may be evaluated in a qualitative manner by examination of their general appearance. Thus, from such things as the shape of the peaks, the distance between peaks, the heights of the peaks and the depth of the valleys, etc., an approximate evaluation of the surface can be made. Alternatively, it is possible to obtain a numerical value of the average surface roughness of the specimen. A meter can be used in conjunction with the surface analyzer which will read directly the rms (root mean square) value of the surface roughness.

Since this rms meter serves to integrate the departures of the diamond point from the average surface level, other techniques are permissible in securing an integrated value for determining the average departure from true surface level. For example, a planimeter or conventional graphical techniques can be used to integrate the trace of the surface. Empirical graphical techniques are available too for somewhat more convenient estimation of roughness.

In the application to randomly roughened surfaces, there are drawbacks to the use of this type of instrument. The diamond tracer point, although supplied with a radius as small as 0.005 in., is still too large to probe many of the etched areas, and the instrument itself is incapable of exploring undercut regions. In addition, there is a tendency for the diamond point to mar and modify the surface which it traces. Only a small area of the work is examined during one run with the instrument, and the possibility of a nontypical sample must be recognized. Finally, an appreciable amount of time must be spent in the graphical analysis of each trace before differences in similar samples can be detected.

In justice to this type of instrument, it should be observed that it is very well designed to detect the "smoothness" or relative absence of roughness on a surface. It is not adapted to the problem of identifying the type of roughness or its character.

Reflection Methods

Optical methods have been mentioned by many investigators as being applicable to the measurement of surface characteristics. Such a method involves measurements of surface brightness as a function of the angle of a view and also as a function of the angle of illumination. A highly polished surface exhibiting specular reflection will possess a curve of brightness vs. angle of view which falls off rapidly on either side of this point. On the other hand, the curve of brightness vs. angle of view will be relatively flat for a well-etched surface exhibiting diffuse reflection.

A modification of this method which has been used with some success consists of fixing the angle of view at some convenient angle; say 45 deg. Thus, with a fixed source of illumination, one value of the intensity of the diffusely reflected light could characterize the reflecting surface. An accompanying figure is a diagram of a simple light box which can be used for this purpose.

This simple technique has much to recommend it. The rapidity with which the test can be conducted, the relatively large area of the sample examined and the nondestructive nature of the test are all readily recognized advantages. However, the ability of this method to discriminate satisfactorily between samples whose surfaces differ only slightly is poor. The instrument might not be able to detect differences between two samples having identical "topographies" where one has a considerable degree of undercutting which the other lacks. A complete 180-deg angular traverse with a narrow viewing slit would probably reveal more of this subtle detail.

An obvious point sometimes overlooked is that all samples should have surfaces of the same color and tint and be free of oil and dust. These precautions tie in with the desirability of having the light source match the wave length at which the photocell gives peak response.

Observation with Binocular Microscope

A most satisfactory and informative technique involves use of a binocular microscope at magnifications of 40 to 150 dia. As a result of extensive microscopic observation on large numbers of samples, the terms used to characterize the surface were evolved. The large depth of focus provided by the microscope enables the viewer to see, with the aid of oblique illumination, the entire depth of the surface. Such things as degree of undercutting, the shapes of the peaks and valleys etc., are readily visible.

It has been our experience that, after a short period of familiarization with the appearance of the different types of etched surface, it is possible to dispense with the use of a "standard surface" for side by side comparison. Undoubtedly a measurement technique of this type depends primarily on the skill, experience and judgment of the observer. However, the convenience, rapidity, economy and reliability of this method go a long way toward justifying the use of this somewhat nonobjective method of evaluation. Furthermore, the instrument can be set up in any convenient location without regard to special provisions for power and auxiliary equipment. Observers can be trained to use this tool in a very short time.

An accompanying photograph shows a chemically etched surface taken through a monocular microscope at 150 dia. This photograph is only an approximation to the clear picture obtained when the surface is viewed through a binocular microscope. Still, one can appreciate the wealth of information presented to the eye. It is not to be expected that the memory will retain this detail except when repetitive routine comparisons are being made. Standard surface samples are useful for more general studies.

Special Methods

With the exception of the surface analyzer, all of the foregoing techniques call for inexpensive equipment or equipment which can be readily constructed and which can be conveniently applied in the average laboratory or plant. But these do not represent a complete listing of possible approaches.

Special methods for the examination and characterization of surfaces follow. These require techniques and equipment not so readily available, but which may be called for as the needs of the problem dictate.

Electron Microscope—The electron microscope is a transmission-type instrument which depicts the subject under examination by means of shadows created by the specimen in

the path of an electron beam. Consequently, in the examination of metal surfaces, either extremely thin sections of metal must be employed or, where this becomes impractical or inapplicable, replicas of the surface can be used.

Due to the extreme magnification of the instrument, only very small sections of the surface can be examined. This constitutes a disadvantage as outlined in previous sections. Furthermore, because of the variations in density of the photographic image due to varying lengths of the paths the electron beam must follow, a densitometer must be used for quantitative interpretation of the results. In other words, the electron absorption, which is proportional to the distance through which the beam must travel in the metallic or replica medium, will cause varying light and dark areas on the film representing peaks and valleys in the surface. Considerable time must be spent, therefore, in interpreting the photographs obtained with the instrument. Moreover, skilled operators must be employed for the operation of the electron microscope.

Electron Diffraction Method—This method of examination receives only brief consideration, since the process of diffraction takes place in a very thin surface layer and the diffraction patterns so produced are not by reflection from the main surface nor the region below the "apparent" surface level but rather by peaks which rise above the main plane of the surface. Furthermore, a necessary condition is that these peaks must be very thin lest they absorb the impinging electrons. Finally, it is necessary to use almost grazing incidence and thus much of the surface is hidden by shadows of prominent peaks.

Parallel Plane Clearance — This method involves the use of a smooth surface to contact the etched surface using a gas or liquid of low viscosity to estimate the clearance between the two surfaces. For example, the clearance which is a measure of the average surface roughness can be determined from the amount of air leaking between the surfaces in a definite time and under a definite pressure. The paper industry uses an instrument based on this principle which is known as the Bekk Smoothness Meter, while an instrument called the Solex Micrometer has been used to measure surface roughness on metal surfaces.

It is obvious that much special equipment and correlation of data must be employed with this method. Moreover, the "character" of the surface which has been shown to be critical in determining the degree of selenium adhesion, for example, would not be described successfully by this technique.

Gas Adsorption—The gas adsorption method for the determination of surface area is based on the assumption that a definite amount of adsorbed gas covers the whole surface of the specimen with a uniform, unimolecular film. From the adsorption isotherm of the gas employed it is possible to calculate the area of the adsorbent. However, the validity of the assumption upon which the method is predicated has been questioned in a very penetrating manner by Bikerman, who offers several examples which indicate the importance of careful examination of this premise.

Liquid Adsorption — There are three general methods of determining the surface area of an absorbent by liquid adsorption; one corresponding to gas adsorption methods and two using radioactivity.

The adsorption method is based on the property of surfaces to adsorb polar molecules. Thus, when a surface is placed in a liquid such as a dilute solution of an organic dye, the change in concentration of the dye is a measure of the adsorption. If the cross-sectional area of dye molecules can be determined and if the thickness of the adsorbed layer is known, the area of the absorbent can be computed.

Some of the difficulties in application of the procedure are implicit in the foregoing statements. Other limiting considerations arise from the fact that often the solvent as well as the solute is adsorbed and further, that in the adsorption of ionized substances, exchange adsorption, also called ion exchange, is to be expected. Exchange adsorption is a property of either impurities in the adsorbent or its bulk, and only in exceptional cases can it be expected to give a value proportional to the surface of the adsorbent. Finally, if the adsorbent has a spongy porous surface, it can be expected that the solute molecules may be larger than certain of the pores which will, therefore, remain undisclosed by the method of measurement.

The radioactive exchange method is based on the change in radioactivity of a solution of a material like Thorium B after equilibrium is reached in the adsorption process. Since the adsorption is postulated as occurring entirely by an ion exchange mechanism, the increase in concentration of the adsorbent in the solution is proportional to the decrease in radioactivity of the solution. The process should, therefore, be independent of the size and specific area of the crystals of the adsorbing surface. While this method is directly applicable to powdered adsorbents and yields information concerning the volume to surface area ratio of the particles, it would appear possible to apply this technique to larger surfaces, perhaps calibrating against a true geometrical surface such as is presented by mercury. Results obtained with the radio-active exchange method correlate fairly well with those of the polar liquid adsorption method, yielding results of the same order of magnitude.

A method based on the incorporation of a radioactive material into the substances whose surface is to be measured is called the radioactive emanation method. Assuming uniform distribution of the radioactive compound throughout the body of the material under examination, the radioactivity of the air in the neighborhood of the surface is a measure of the number of radioactive atoms in a thin surface layer. From this measurement it is possible to compute the extent of the surface. However, the amount of emanation reaching the air is due to other factors as well as to the decomposition of the radioactive material in the surface layer. Emission is aided by diffusion in permitting emanation atoms to escape and be measured. Furthermore, rough surfaces and powdered agglomerates may act to recapture atoms emitted from other areas and prevent their measurement. In general, evaluation of experimental results is very difficult and the method is employed only to give qualitative conclusions.

Electrolytic Method—On the assumption that the capacity of the double layer at the interface of a given liquid and an electrode is independent of the nature of the electrode, measurement of this capacity offers a method of determining the real surface area of the electrode. Since the capacity of an electrode is directly proportional to its area, upon comparison with a mercury

electrode which has a real area equal to its geometrical area, the real area of the electrode under investigation can be readily computed. Kabanov and Yudkevich have used this method for the measurement of true surface areas. They report a value of about 18 microfarads per sq cm as being characteristic of all smooth metal surfaces. The value of 222 microfarads per sq cm is reported as typical of the surface of one of the lead electrodes with which they worked. Calculation shows this value of capacity corresponds to a real surface area 12.3 times the apparent geometric area.

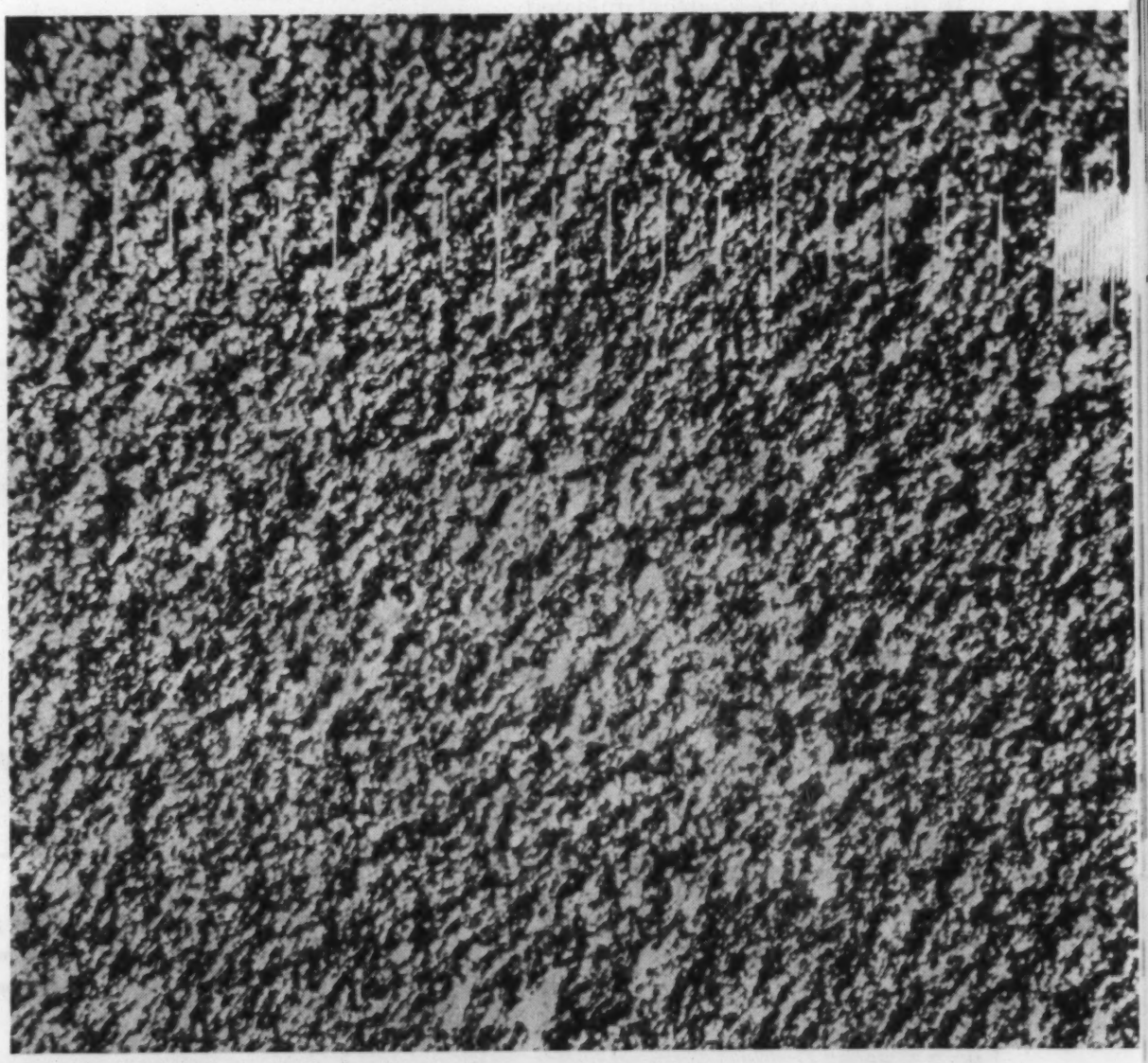
The electrolytic capacitor industry uses a modification of this technique in measuring the effectiveness of their etching process for aluminum. An anodic oxidation process produces an oxide film on the aluminum surface which serves as the dielectric of the capacitor. The thickness of the oxide film is a function of the applied voltage, and if this voltage is kept constant, the capacitance will vary as the surface area produced by the etching process. A ratio of the capacitance of the etched aluminum to the capacitance of the unetched aluminum will give a single number, referred to as the Etch Ratio, which effectively characterizes the surface roughness.

Conclusion

Of the methods discussed for characterizing an etched surface, the most generally useful and satisfactory is direct observation with a binocular microscope. Using this instrument in conjunction with samples of standard surfaces, reliable judgments can be made regarding even the more subtle surface characteristics.

It is true, of course, that this method does not permit the assignment of numerical values to the surface parameters described earlier in this article. However, experience has shown that the particular surface property of interest may not be at all related to the numerical value obtained by one of these approaches. It must be recognized that it may not be possible economically to give quantitative expression to all of the less gross surface features. In such a case the search for objective measurement techniques can and should yield to a sound subjective approach. Here, the human eye, which is a remarkable tool, can be called upon to play a major role and with a little experience, play it sucessfully.

***SURFACE ANALYZER** uses a diamond tracer point which travels over the surface of the specimen, producing a written record as shown or yielding a numerical value.*



***PHOTOMICROGRAPH** of a chemically etched surface which approximates the appearance of a surface viewed through a binocular microscope (150 magnification).*

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by W. E. KUHN,
Titanium Alloy Manufacturing Div.,
National Lead Co.

Titanium and Zirconium Casting

● IN RECENT YEARS extensive advances have been made in the production of titanium and zirconium, notably in producing sponge, converting sponge into ingots, and reducing ingots into useful engineering shapes by forging, rolling, machining, or combinations of these operations. However, the production of castings has been difficult because of the reactivity of these metals with gases and mold materials. Now, a process for melting and casting titanium, zirconium and their alloys has been developed which has potentialities as a manufacturing procedure for castings ranging from several grams to several pounds.

In this new process uncontaminated castings are produced which are close enough to the final form and size to be called precision castings. Melting titanium free of contamination is accomplished by means of an electric arc in an inert atmosphere arc furnace. The chances of successful castings of high melting point metals such as titanium and zirconium by this method are good because (1) the time required for the metal to cool from arc temperatures to the freezing point is long enough to permit the metal to flow through a sprue and fill a mold cavity; (2) the fluidity of the metal is considerably greater at arc temperatures than at temperatures only a few degrees above the freezing point; and (3) the low viscosity of the super-heated metal materially increases its chances of reaching and filling the mold cavity.

The equipment designed to incorporate these ideas is shown in an accompanying sketch.

Casting Procedure

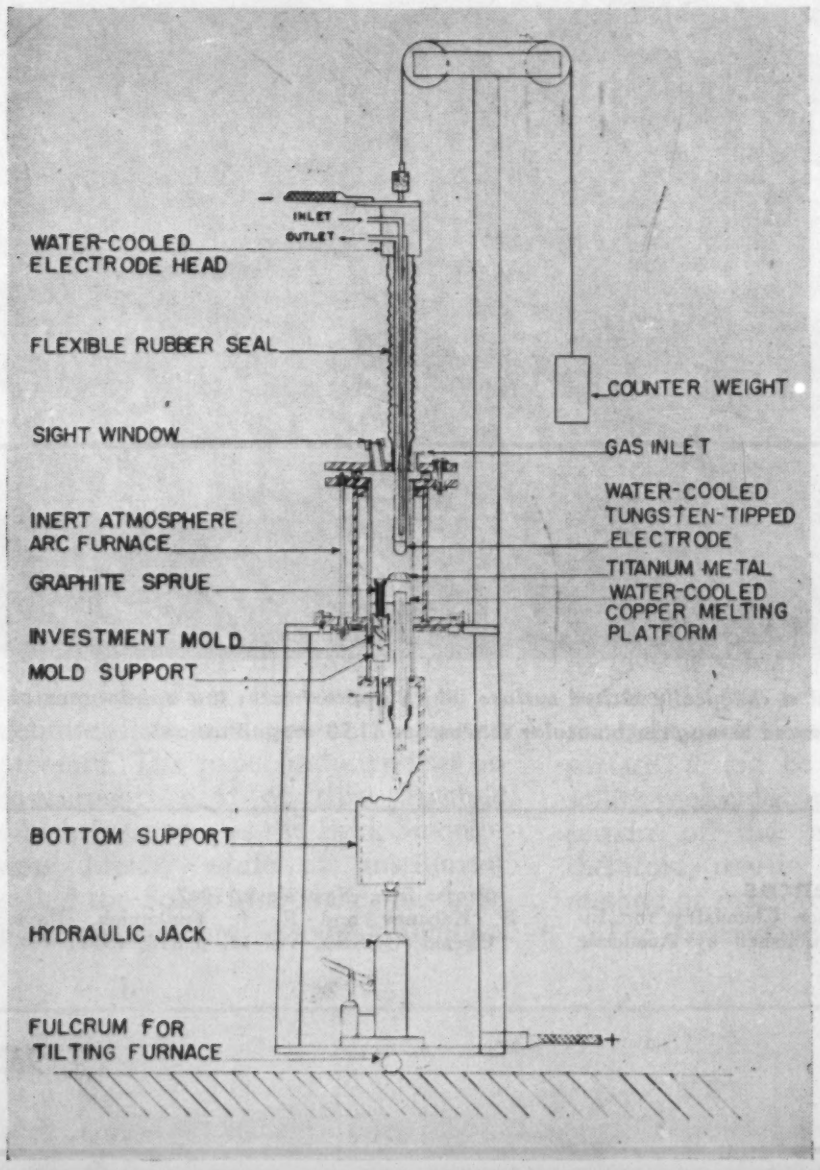
Titanium or titanium alloys are melted under argon on the water-cooled copper platform shown in the sketch with the furnace inclined to the right at an angle of 30 deg from the vertical so that the metal is contained between the copper bottom and the water-cooled walls of the crucible. After melting with an arc current of about 600 to 800 amperes for about 1½ to 2 min, the metal is molten and ready to cast. Tilting the furnace to the left causes the molten metal to flow through the sprue opening into the mold. Because of the rapid cooling, the small casting may be removed about 5 min after pouring.

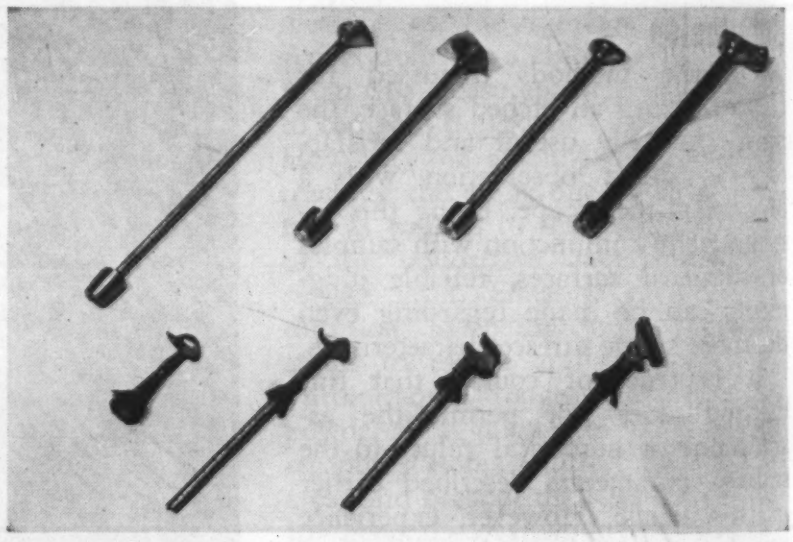
Two methods of casting can be employed.

Vacuum Casting—Metal is initially melted under atmospheric pressure of argon for about ½ to 1 min, after which the pressure is reduced to the desired vacuum. This can range from atmospheric pressure to 20 in. mercury vacuum. Using the tilting technique described, the metal is cast under vacuum. This method can be used for producing relatively large diameter rods and heavy castings.

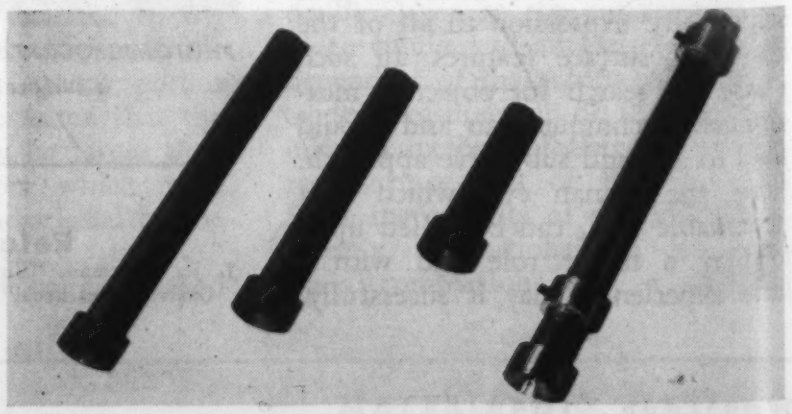
Pressure Casting—In this method argon is admitted through a port in the cover of the furnace and drawn through the sprue opening in the water-cooled melting platform and a port below the mold by the suction created by a vacuum pump. Metal is

***ARC MELTING AND CASTING EQUIPMENT.** Furnace is tilted to the right for melting and to the left for casting.*





***TITANIUM RODS** as cast (top) and sand blasted precision castings of sewing machine parts (bottom). Tapered cylinder at bottom of each rod is excess metal which collected in a copper vessel placed at the end of the rod to prevent spattering.*



***COPPER (RIGHT) AND GRAPHITE MOLDS** are used for the production of rods.*

ow Practicable

Castings ranging from several grams to several pounds can be produced by new process. Development can be exploited for permanent mold castings and lost wax investment castings.

melted while maintaining a flow of argon through the furnace. When the furnace is tilted for casting, the metal flows into the sprue opening and is acted upon from above by pressure and below by vacuum. The difference in pressures above and below the metal injects the metal through the spruce into the mold cavity. This method can be used for producing long bars of very small diameter by using the sprue as the mold.

Contamination of reactive metals such as titanium and zirconium by the mold material can be minimized by casting into molds of high thermal conductivity. These molds do not give the metal an opportunity to pick up objectionable impurities while in contact with the mold material because of the rapidity of cooling of the melt.

Mold materials exhibiting a wide range of physical properties have been used. Rods have been successfully produced in both graphite and copper molds of the type illustrated. An example of the results achieved is the casting of titanium rods, 7 in. long and 1/8 in. in dia. For making the investment molds, special cements were developed in the ceramic laboratory. Investigation of mold materials is being continued with encouraging results.

Hardness measurements of the metal before and after casting indicate little or no increase in hardness of titanium or zirconium metal cast into small molds made of graphite, copper and investment cements.

Castings Produced

Some products of the preliminary development work are shown in an accompanying figure. It is perhaps noteworthy that the first run produced the 1/4-in. dia by 4-in. long rod shown in the upper righthand corner of the photograph. Subsequent experiments with the process produced the other products shown. The tapered cylinder at the bottom end of each rod is the excess metal received by a small copper receptacle placed against the end of the rod mold to prevent metal from spattering over the interior of the furnace.

Using molds of the type shown in another illustration, rods up to 7 in. in length and ranging from 1/4 to 1/8 in. in dia have been produced. There is a good reason to believe that rods 1/16 in. in dia and of considerable length can be cast by this method.

This process has proved extremely useful in preparing rods for electrical resistivity measurements, and for stress-rupture bars of both forgeable and non-forgeable alloys. Bars of relatively brittle intermetallic compounds can also be prepared in this way.

The success obtained with the production of rod castings prompted experiments to produce small precision castings of titanium using investment mold materials. The results of some of these experiments are shown. The method of mounting the investment mold is illustrated also, and the casting procedure has already been described. Sections taken through some of the castings indicate that they are sound and free of shrinkage cavities and blowholes.

Industrial Precision Castings

The principle and basic design described can be applied to the construction of industrial scale arc casting units for making small castings in quantity. Such a development could be exploited commercially in two directions: permanent mold castings made in copper or graphite molds, and investment castings made by the lost wax process.

Industrial development of the arc casting process could provide a partial solution to the problem of disposing of scrap titanium and zirconium and their alloys. Scrap metal has been used throughout the development work and has provided ideal melting stock free of spatter and chlorides, thereby facilitating the furnace operation and resulting in indefinite life to the tungsten electrode tip, copper crucible, and water-cooled copper melting platform.

It is the writer's opinion based on experience with the use of copper molds that it is entirely feasible, for example, to produce compressor blading for turbine engines by this process in permanent molds. In general, wherever there is an industrial need for small, complex parts which are difficult to machine to required tolerances or which are impossible to machine in the proper alloy of titanium or zirconium, this process can be applied. Precision castings of zirconium should find wide use for prosthetic casting, cranioplasty, etc. since the alkali resistance of zirconium is greater than that of tantalum. The casting of dentures should prove another application for precision castings of zirconium. The use of titanium for components of instruments and equipment where lightness is an advantage and/or resistance to corrosion is a desirable feature is a possible application.

Future development will undoubtedly bring about additional applications of this process for the casting of refractory metals, intermetallic compounds, carbides, etc., into shapes.

The applications of an arc casting process in metals research laboratories are too numerous to mention in detail. It suffices to say that, through its ability to produce rod specimens of almost any high melting point metal and alloy regardless of whether it is ductile or brittle, this process opens up the entire field of study of alloys and their compounds by electrical resistivity methods. It will result also in great saving of time in the preparation of samples for microscopic studies, tensile and stress rupture test bars, test specimens for corrosion studies, and many similar articles.

Acknowledgments

The author wishes to express his appreciation to the management of the Titanium Alloy Manufacturing Div., National Lead Co., and in particular to Dr. S. Urban, Director of Research, and Mr. R. S. Stewart, Assistant Chief, Physical Metallurgy Div. Thanks are due to Mr. A. Hudson, Mr. R. Buresch, Mr. Chester Winiarski, and other members of the laboratory staff, and to Mr. Charles Mahoney, who assisted in the construction of the arc casting furnace and molds. The ceramic materials were prepared by the Ceramic Div.; special acknowledgment is given to Mr. W. J. Baldwin, Chief, Ceramic Div., and Mr. A. J. Hathaway, Senior Ceramist.

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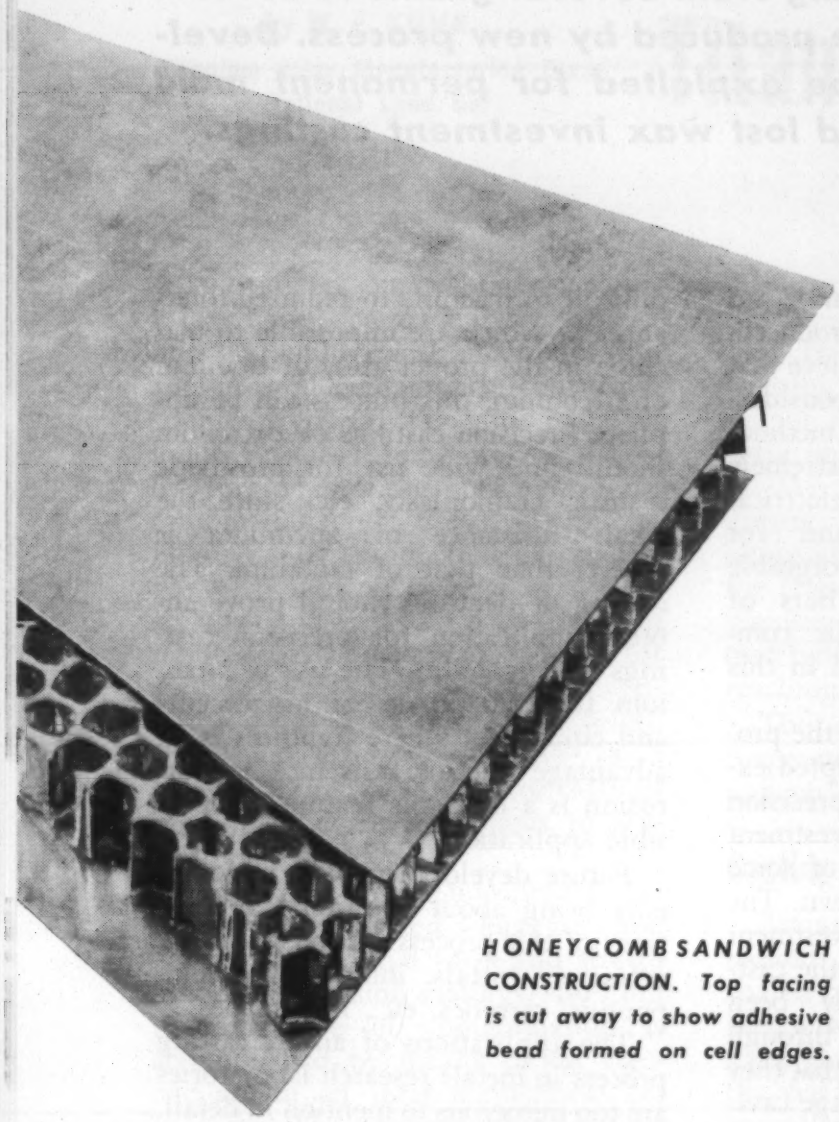
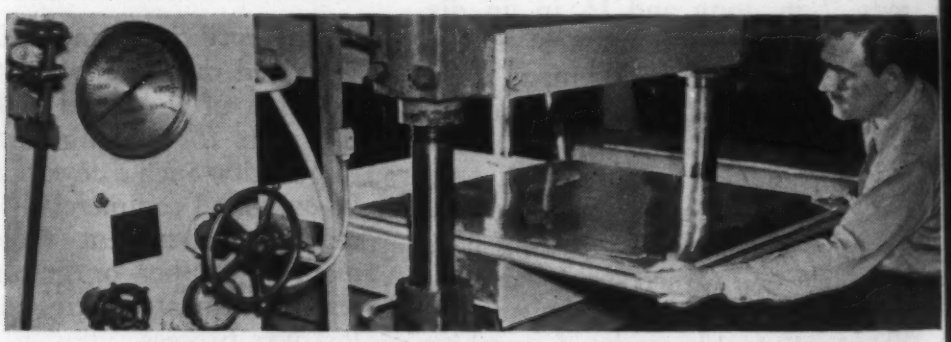


HONEYCOMB SANDWICH CONSTRUCTION. Top facing is cut away to show adhesive bead formed on cell edges.

FLAT PANEL CONSTRUCTION

1—Core billets are bond-sawed to the proper thickness for flat panel construction. Core slices on the floor at right.

2—Honeycomb cores are assembled with inserts and side panels into flat sandwich panels of various sizes.



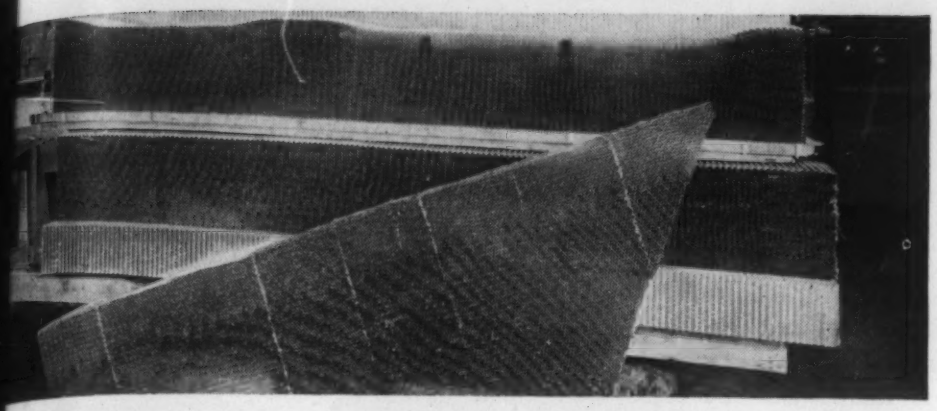
3—Final processing of flat sandwich consists of exposure to pressure and curing temperature of 310 F in a platen press.

Aluminum Honeycomb Sandwich Has.... Light Weight High Strength Good Stability Uniform Density

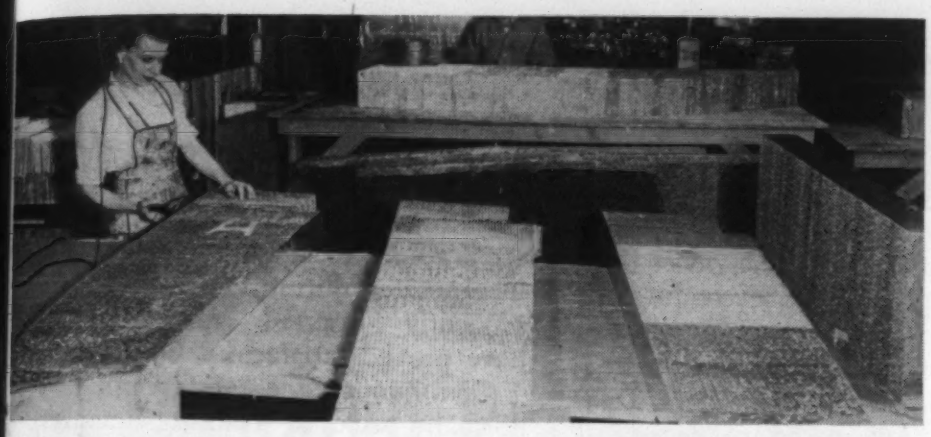
by Philip O'Keefe,
Associate Editor, Materials & Methods

● REFINEMENT IN design, adhesives and fabrication techniques in the last five years have put aluminum honeycomb into volume production. Strength and light weight are the advantages. This material is widely used structurally for rigid panels and contoured shapes in aircraft and other products.

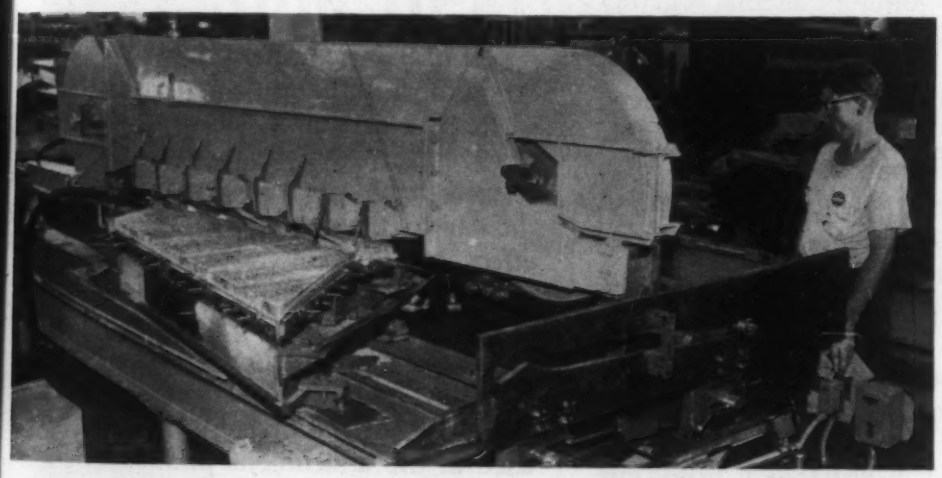
Honeycomb sandwich construction consists of two metal sheets bonded to a cellular core. The core is usually made of aluminum foil. The foil is corrugated and bonded together at



1—Slices sawed from billets are fitted together to form solid section with approximate plan form of finished component.



2—Cores, trimmed to plan form dimensions, receive a strip of aluminum foil around vertical edges.



3—Horizontal band saw cuts core to the correct contour. Cam running in track at right guides the blade.

the crests of the precorrugated sheets of foil, then stripped with adhesive, bonded together and expanded to produce a pattern of small hexagonal cells.

The history of honeycomb began in a research program initiated by The Glenn L. Martin Co. about 10 years ago. Flooring for commercial aircraft was an early application. The material was also used for saucers of ground radar antennas. Later it formed the complete tail and wing assemblies of the Navy KDM-1 guided missile. These successes—plus the development of adhesive film and cores of small cell size—now point to the consideration of honeycomb for use in primary structures of aircraft.

Materials and Properties

For structural application, aluminum foil has the following advantage over other core materials: (1) higher compressive and shear strength; (2) higher shearing modulus; (3) greater dimensional stability; and (4) uniformity of foil thickness—and hence, of course, density. The density can easily be controlled by varying cell size or foil gage—or both. Core material is available in 1/8-, 3/16-, 1/4- and 3/8-in. cell sizes. Foil gages range from 1 to 6 mils. As a rule, 3-S aluminum alloy foil is used.

The strength of honeycomb sandwich construction depends primarily upon core density, facing thickness, adhesive bond and the overall depth of the sandwich. The strength of any panel can be modified locally, of course, wherever attachments, holes or reinforcements are introduced.

A major portion of loads is carried by the metal facings. Their function is to provide stiffness, stability and configuration. In some cases, surface smoothness is significant. Surface smoothness is a prime factor when the panel serves as an airfoil or is required to resist compressive stresses in the plane of the facings. Facings must resist applied axial, tensile and compressive force of various magnitudes. These stresses determine the alloy type and gage of the metal. In aircraft uses, the high strength aluminum alloys, 14 S-T, 24 S-T and 75 S-T, have been chosen exclusively. Sheet thicknesses employed with a 3/8-in. cell range from 0.016 to 0.064 in., and as high as 0.120 in. with adhesive-bonded laminated skins.

The adhesive used to bond the foil segments of the honeycomb cells together and to bond the core to the facing sheets is a mixture of thermosetting and thermoplasic resins. The resins are held in a solvent to a solids content of about 20%. Properties of this adhesive include high shear and tensile strength, good creep resistance up to 160 F, considerable insolubility in organic solvents, and high resistance to humidity.

A film adhesive is coming into use for applications in which heavy duty impact and high stripping strength are required. The film, which is supported by a woven glass cloth matrix, weighs from 0.025 to 0.070 lb per sq ft. Advantages of the film adhesive are: (1) uniformity of the bond; (2) higher peel resistance; (3) fewer coats of adhesive required; and (4) reduced number of air-drying steps. In the liquid form, successive applications of the adhesive are required to build up an adequate bead.

Adhesive failures usually involve

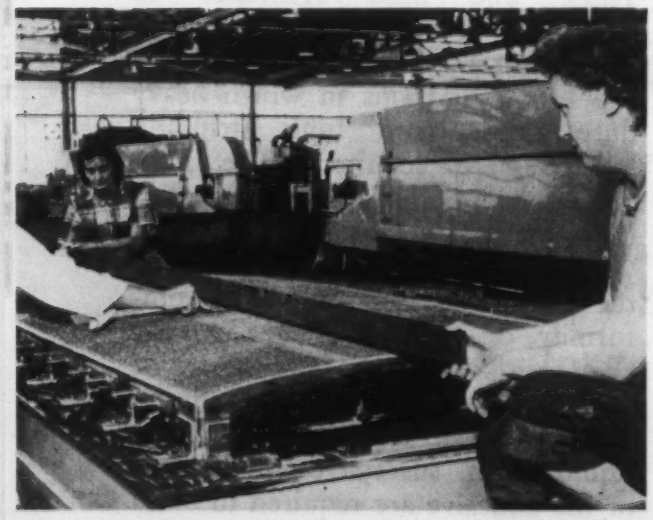
either failure of bond between the adhesive and the facing sheet, or failure of bond between the adhesive and the core. In some instances, failure is accompanied by tearing of small portions of the lower-density cores. Minimum requirements for aircraft structural applications, in addition to USAF Spec. 14, 164 are as follows: (1) strip test toughness factor of 50 and 15, with and without film, respectively; (2) creep at 160±2 F of 0.030 (max in 24 hr).

The success of this fabricating process in production depends on careful inspection and quality control measures throughout the various stages of the process. High standards of cleanliness and strict conformance to good bonding procedures are major factors in the efficient application of adhesive bonding in primary structures.

Manufacture and Fabrication

The metal facing used in construction of aluminum honeycomb is cleaned by anodizing—with omission of the sealing operation. The surface is exposed to the anodizing treatment for 10 to 15 min. The adhesive is then sprayed on to a thickness of 0.003 to 0.004 in. The sprayed-on adhesive is dried in air for 16 hr. When the adhesive is applied in film form, 2-hr drying time is sufficient.

To make flat honeycomb panels, the entire assembled sandwich is bonded together in one step. The core is first sliced to the proper thickness on a band saw. The adhesive coating is then applied to the core, either by brush, roller coater or spray. This adhesive coating is allowed to dry in air for 16 hr. The metal facings and core are then assembled into a bonding fixture and force-dried at 225 F for an hour. The final processing takes place in a platen press for 20 min at 310 F.



4—Contours are checked against a master gage. Corrections can be made easily in the fixture.

The fabrication of curved panels differs from that of flat panels. The core is first shaped on a contour mold, after which the adhesive is spread on and dried. The facings are cut to size and formed over molds before being assembled to the upper and lower sides of the core. The sandwich is finally bonded together by heat and vacuum-bag pressures. The curves in panels made in this way must be simple, with reasonable large radii.

A more complex method is used to make solid contoured structures. The core is not bent, but is cut to the proper contour with a special band saw. Wing panels and other highly stressed components of missiles are made in this way. These solid structures are the most advanced type of honeycomb end product.

Billets of core material are cut to approximate size and thickness on a band saw. Any necessary densification of the core is accomplished at this time. The core is formed by coating these cut-down billets with adhesive — joining them together with the same adhesive used in the fabrication of core material—by air drying and by heating in an oven at 300 F for 30 min. The assembly is then trimmed to the exact plan outline of the finished component. A strip of aluminum foil is bonded around the outline edge to provide a bonding surface for mating assemblies.

The contours of the top and bottom surfaces are formed by a special technique. The core is clamped in a fixture, and a horizontal band saw guided by cams moving in a track at the sides of the machine cuts the surface to the correct shape. A rough cut, followed by a finished cut, is made. Tolerances of —0.000 +0.010 in. can be held. The other side of the core is contoured in the same way. Adhesive is then applied and air-dried for 16 hr and force-dried for 1 hr. The metal skins, already formed to the right shape, are then assembled to the core.

The honeycomb structure is subjected to the required temperature and pressure in a special autoclave. Air instead of steam is used in the autoclave. Temperature and pressure can thus be adjusted independently, and the temperature can be lowered more slowly than in a steam autoclave. Moisture on the assembly is eliminated. Air in the autoclave is circulated at 20 mph. The maximum operating temperature is 365 F, and the internal pressure can be brought up to 100 psi. Selective pressures can also be applied simultaneously to local areas by special tooling. This is another of the improvements built into the autoclave. Pressures currently employed are 3, 15 and 100 psi.

Installation

In attaching sandwich parts to similar parts or to framework, the concentrated loads imposed by the attachments must be distribtued. Densification (compressing the core) or reinforcement (incorporating additional foil strips across the centers of the cells) serve to withstand high crushing loads. In most structural applications, local reinforcements are incorporated during fabrication. Subsequently inserted reinforcements have proved satisfactory, however.

Continuous edge reinforcement is normally used at framing member joints to protect the core and facilitate installation. Factors in selecting the edge reinforcement are: (1) loads to be transferred; (2) kind of attachment fittings; and (3) importance of surface smoothness. High-strength inserts can be end-grain mahogany or spruce, plywood, metal or reinforced plastics. Plywood should have plies running perpendicular to the facings to reduce the effect of different rates of thermal expansion between the metal and wood.

Where high loads are transferred at points other than edges, such as over ribs or bulkheads, inserts are used at the attachment points. These may be strips, inserted continuously across the panel, or local reinforcements under bolt fittings. The relatively low crushing strength of the core would result in a dented surface if the attachment were made on a plain panel. Joints in the facings are required whenever the available facing-sheet widths will not cover the size of the part. An offset in the top facing provides a flush joint but causes eccentric forces in the panel and decreases the facing's load capacity under compression. Proper placement of doubler plates will assure maximum strength.

Acknowledgment

All information and pictures used in this article were supplied by The Glenn L. Martin Co.

Aircraft instrument bearing retainers are gaged and inspected with balls in place. Tests are made for pitch diameter and concentricity.

Laminated Plastics Improve Precision Bearing Performance

Cotton fabric phenolic laminates meet bearing requirements imposed by high-speed operation of precision parts.

by HERBERT WIDDOP, Synthane Corp.

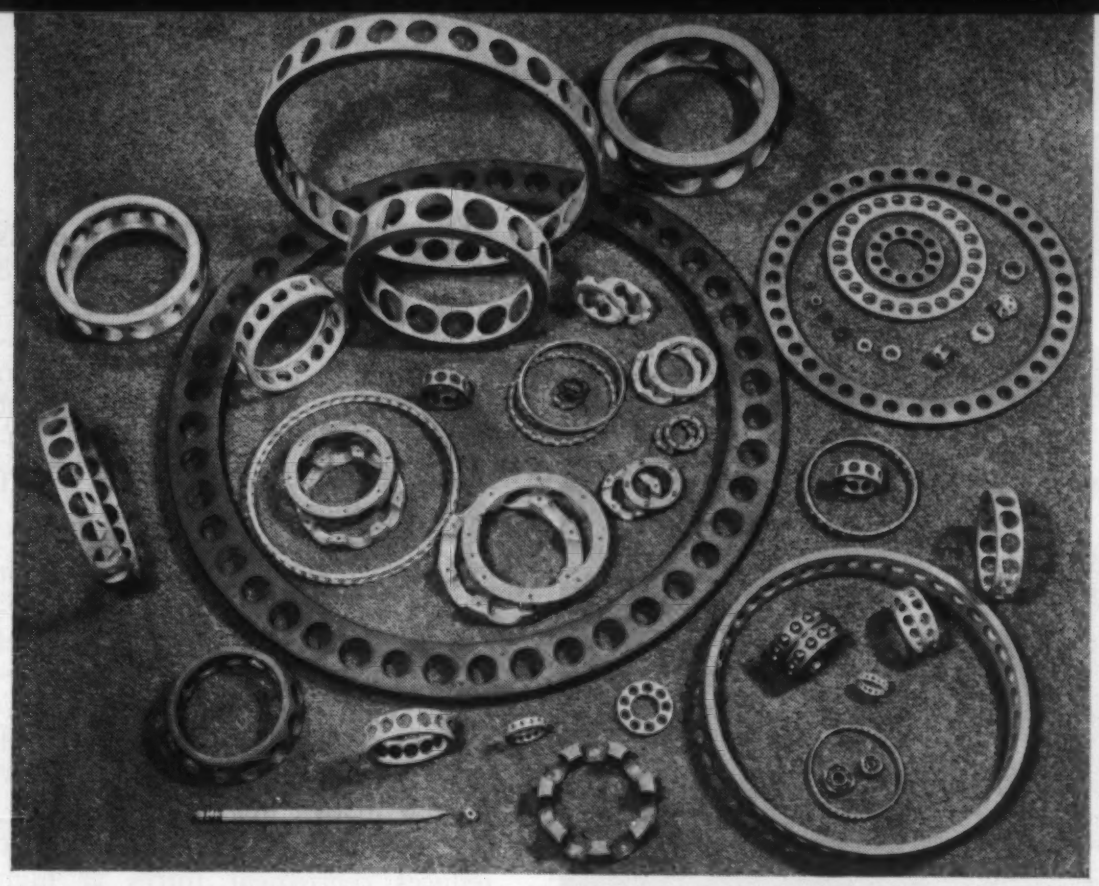
● THE INCREASING SPEED at which precision machine tool and instrument bearings are being operated places correspondingly severe demands on the ball retainers. In sound bearing application, therefore, consideration must be given to the type of material from which the retainer is fabricated. For low-speed applications, pressed steel and bronze retainers give adequate, dependable service. But where high-speed rotation of precision parts is concerned, metallic retainers wear down rapidly, leading to eccentric retainer rotation and decreased bearing life. To meet the demands imposed by high-speed operation, bearing designers have turned to nonmetals, notably to the cotton-fabric laminated phenolic plastics.

Material Properties

Laminated plastics possess a combination of properties which make them more suited to many bearing applications than any other type of material now available. First among these properties is the ability of the laminate to withstand wear in high-speed operation. Direct comparisons between retainer materials are difficult to make because service life is greatly influenced by other factors, such as the alignment and mounting of the bearing, operating temperature, adequate lubrication, and work load. However, for comparable bearings differing only in the type of retainer material, permissible speeds are invariably greater for the laminate type. In certain applications, notably in high-speed wheel heads having an oil-mist lubrication system, speeds in excess of 100,000 rpm are achieved with laminated-retainer bearings. On the other hand, the generally accepted maximum rotation speed for metallic retainers is about 5000 rpm for a bearing with a 50-mm bore diameter. Somewhat higher speeds are possible with bearings having a smaller diameter.

Second, the comparative light weight of the laminate provides several additional advantages over steel or bronze. Small eccentricities in retainer thickness resulting from machining errors have less effect at high rotation speeds because of the smaller masses involved. Moreover, the relative lightness of the plastic reduces centrifugal forces at high speeds. Consequently, the retainer experiences less friction and less wear against adjacent metal surfaces. In addition, starting torques are lower and more consistent with the laminate than with steel or bronze retainers, a factor of some importance in the operation of high-acceleration spindles and instruments. These low starting torques are particularly desirable in instruments in which the moving member must oscillate and change its direction of rotation with minimum lag. A lighter retainer, of course, reduces the total bearing weight, a useful feature in certain installations where the bearing is mounted vertically and the entire radial load is supported by a few balls. Another case where bearing weight is a factor is in epicyclic rotation, where the bearing must rotate about a point other than its geometric center.

The nongalling properties of the laminate offer another important consideration for high-speed work. Absence of galling, which is a temporary sticking or binding between two metal surfaces, is a particularly valuable characteristic of the phenolic retainers, especially where a fast, smooth acceleration is required. Part of the galling tendency in metal retainers results from either insufficient lubrication or drainage of the lubricant away from the sliding surfaces. With the laminate, on the other hand, careful lubrication is less crucial. The material, although virtually impervious to oil and grease, is able to absorb a small quantity of lubricant on its surface by means of the cotton fibers exposed during machining. This absorbed film serves as a kind of lubricating cushion which eliminates galling and which, fur-



Laminated cotton fabric phenolic bearing ring retainers are made in a variety of sizes and types.

thermore, endows the bearing with self-lubricating characteristics.

Other advantages are obtained from the use of laminated retainers. Electrolytic reactions between dissimilar metals, such as between steel and bronze, do not occur. The material is inherently corrosion resistant and has been found to run more quietly and with less vibration than steel at higher speed ranges.

The principal limitation of the laminate is its reduced stability at elevated temperatures. Part of the speed and load limitations placed on the laminated-retainer bearings results from the desirability of keeping operating temperatures below 300 F. However, the useful temperature range is being extended by such manufacturing techniques as heat stabilizing the retainer ring stock. This technique reduces subsequent shrinkage of the retainer and permits stable performance when the bearing is exposed to 275 F continuously and to 300 F intermittently.

Retainer Ring Characteristics

This combination of properties possessed by the laminates makes them highly useful in applications involving high-speed, accurate rotation. Applications include, for example, grinding spindles, machine tools, diamond and carbide boring heads, turbine and supercharger blowers, as well as precision aircraft instruments. The laminates can be machined within the tolerances required for precision and super-precision bearings.

A variety of retainer styles are fabricated from the phenolic laminates for use in precision bearings. Among these are the single row, deep groove; single row, low-angle contact; single row, high-angle contact; and double row, self-aligning. Moreover, phenolic retainers will be found in bearings ranging from 1/4 to 33 in. O.D. The smallest one made by Synthane is 0.100 in. I.D., 0.143 O.D. and 0.088 long, with 6 3/64-in. ball pockets.

Retainers are fabricated from two types of laminated stock—tubing or sheet stock—depending on the type of bearing involved. Tubing is used for most one-piece, radial bearing retainers. However, sheet stock is used for the smaller two-piece retainers whose relatively thin walls might be cracked by rivets. Sheet stock is also used for thrust bearing retainers, and other types in which a large number of holes must be drilled perpendicular to the diameter of the retainer. For these applications sheet stock is preferred because the holes can be drilled perpendicular to the laminations, thereby preserving maximum mechanical strength of the plastic. There are three major types of ball pockets: (1) the snap-in pocket; (2) the Cherry reamed pocket; and (3) the straight-through pocket.

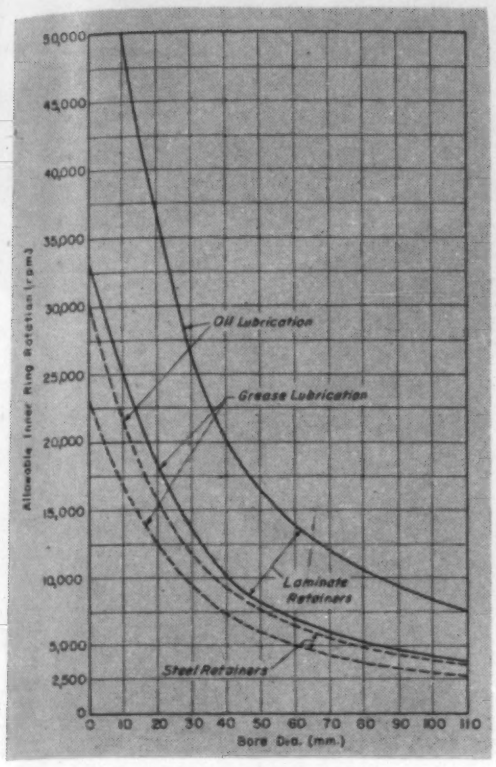
The snap-in pocket, as its name suggests, is designed so that the ball must be "snapped" or forced into the pocket. The diameter of the pocket is largest at the center where the ball spins. The hole at the surface from which the ball is inserted is large enough to permit the ball to pass through when forced, but too small to permit the ball to fall through accidentally. The hole at the opposite end of the pocket (at the inside diameter of the retainer) is of a size which permits the ball to protrude, but not pass through. Thus, a snap-in pocket type retainer can be handled and shipped with a complement of balls without danger of ball loss. Snap-in pockets can be used in either radial or thrust-type bearing retainers.

Typical Properties Cotton Fabric Laminated Phenolic

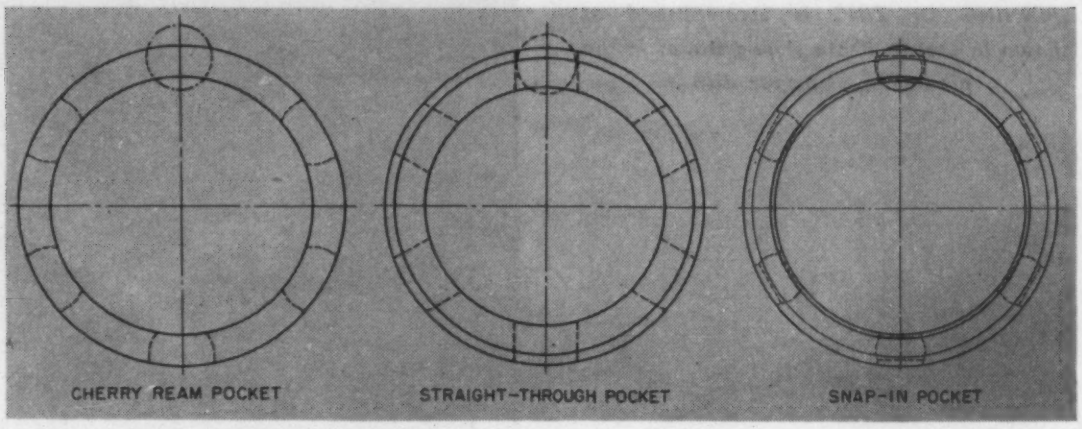
	Sheet Stock 1/8-In. Thick	Tubing 1 3/4-In. I.D. by 2 1/2 O.D.
Tensile Strength, Psi		
Lengthwise	13,500	7,000
Crosswise	9,500	—
Flexural Strength, Psi		
Lengthwise	15,000	—
Crosswise	13,500	—
Compressive Strength, Psi		
Flatwise	37,000	—
Edgewise	25,000	—
Impact Strength (Ft Lb/1 In. Notch)		
Minimum Standard		
Flatwise	1.8	—
Edgewise	1.0	—
Radial Compression, Lb	—	900
Axial Compression, Strength, Psi	—	15,000
Water Absorption (24 Hr) (%)	1.30	1.20
Rockwell Hardness, M Scale		
Flatwise	105	94
Edgewise	95	86
Specific Gravity	1.33	1.14
Dielectric Strength (V.P.M.) (Short Time Test)	360	100
Color	Natural	Natural

All the above tests are made in accordance with ASTM procedures.

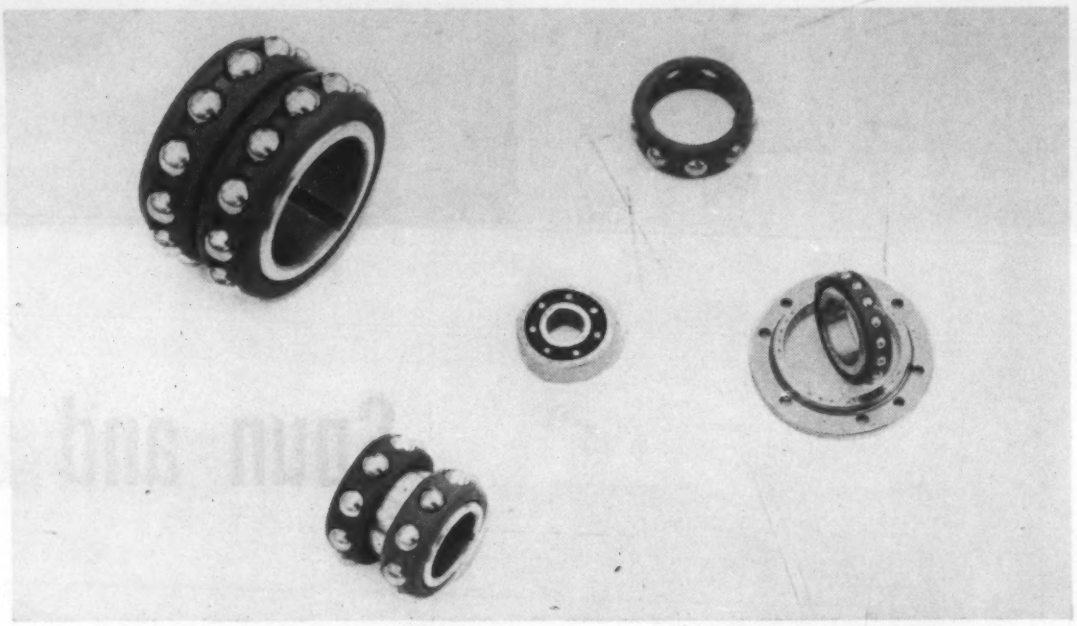
(Tests conducted on Synthane by Synthane Corp.)



Limiting speeds for bearings with laminate and steel retainers. Data apply to extra-light, light and medium series single-row bearings meeting ABEC 1, 3, 5 and 7 specifications. Upper curve applicable to class ABEC 5 and 7 only.



Three common types of ball pockets are used in laminated retainers.



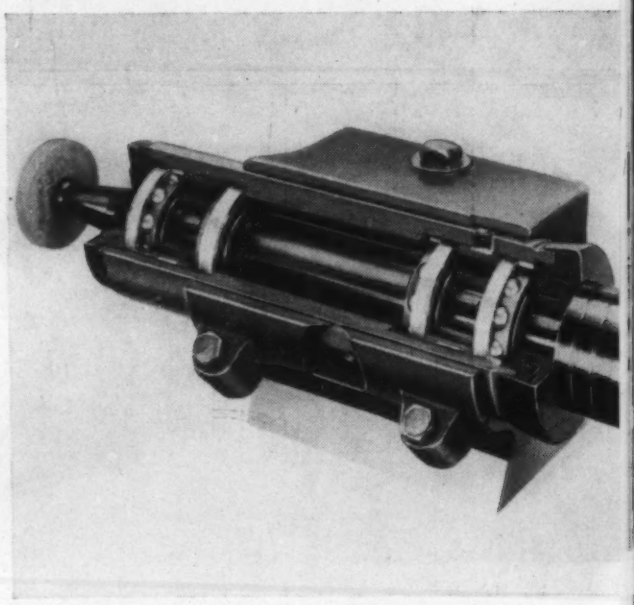
Phenolic laminate retainer rings are used in a number of different types of bearings.

The Cherry reamed pocket consists of a straight hole with a retaining shoulder at one end of the pocket which prevents the ball from passing through. However, once the retainer is loaded, it must be assembled to a bearing race to keep the balls from tumbling out the open end of the pocket during handling. Cherry reamed pockets, used in ball-riding retainers, must be held to extremely close tolerances. In land-riding retainers, Cherry reaming tolerances are not as critical.

Inspection plays a vital part in the fabrication of retainers. Dimensions are checked continually during manufacture. Tolerances for inside diameter, outside diameter, and width across the face are checked after the first rough machining of the blank and again after the final machining. These dimensions are held from +0.005 to +0.001 in., depending upon whether the retainer will be race-riding, ball riding, and upon other considerations of bearing design.

The ball pockets also undergo a series of inspections after machining. Production samples are inspected periodically to check on the accuracy of ball fit in the pocket. In addition, in retainers with Cherry ream or snap type pockets, the pitch diameter of the retainer is carefully checked with a pair of opposite balls in place. Additional inspections determine whether the ring of ball pockets is parallel with the sides of the retainer.

In addition to routine inspection during fabrication, all precision retainers receive a final, rigorous inspection before shipment. Where critical bearing applications are involved, such as in high-speed precision instruments, every pocket of every retainer is checked. Retainers having Cherry ream pockets are checked with a full complement of balls for concentricity and pitch diameter. When a retainer is found with a shallow pocket, the faulty pocket is located by means of a dial gage. This gage consists of a vertical-riding pin having a ball corresponding to the correct pocket size at its lower end. The upper end of the pin is connected by a precision linkage to a direct-reading dial graduated in units of 0.001 in. The dial can be offset to read the correct pocket depth, so that all subsequent readings will indicate deviations from the desired dimension.



High-speed precision bearings like those used on this Van Norman wheel spindle surface grinder often have laminated plastic retainer rings.

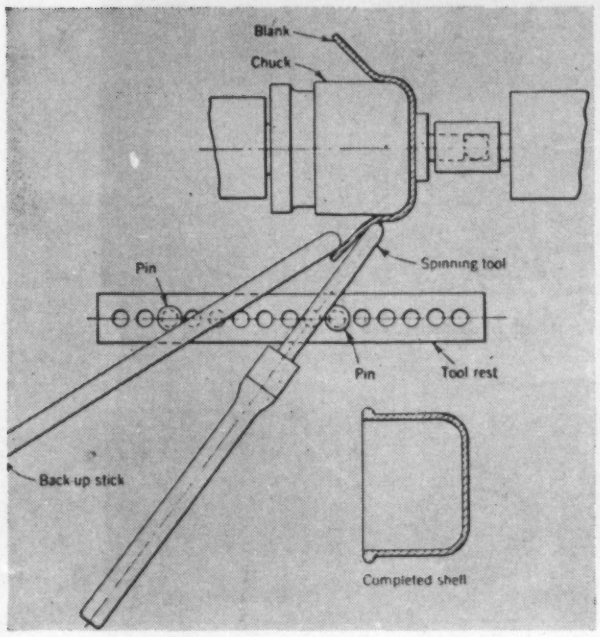
Acknowledgment

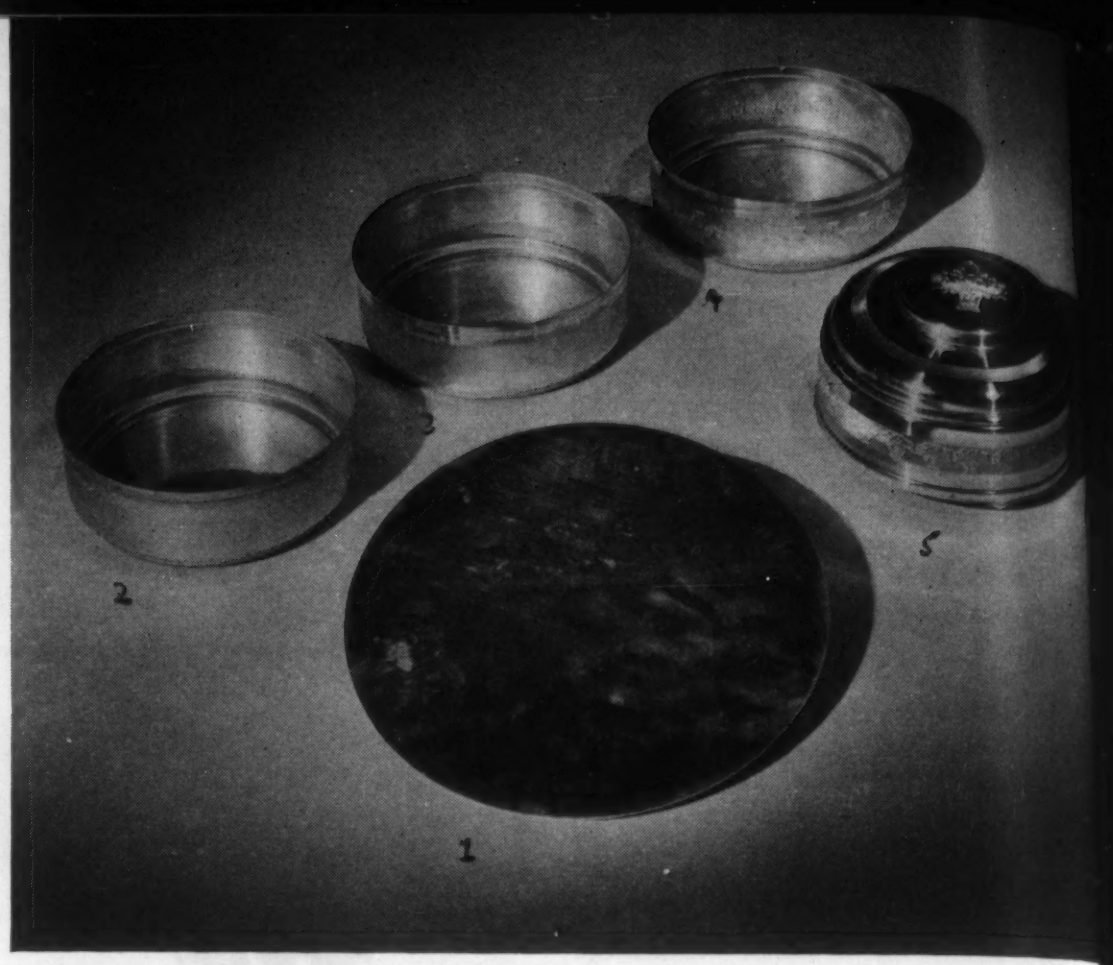
Appreciation is extended to the following manufacturers of precision bearings for their help in preparing this article:

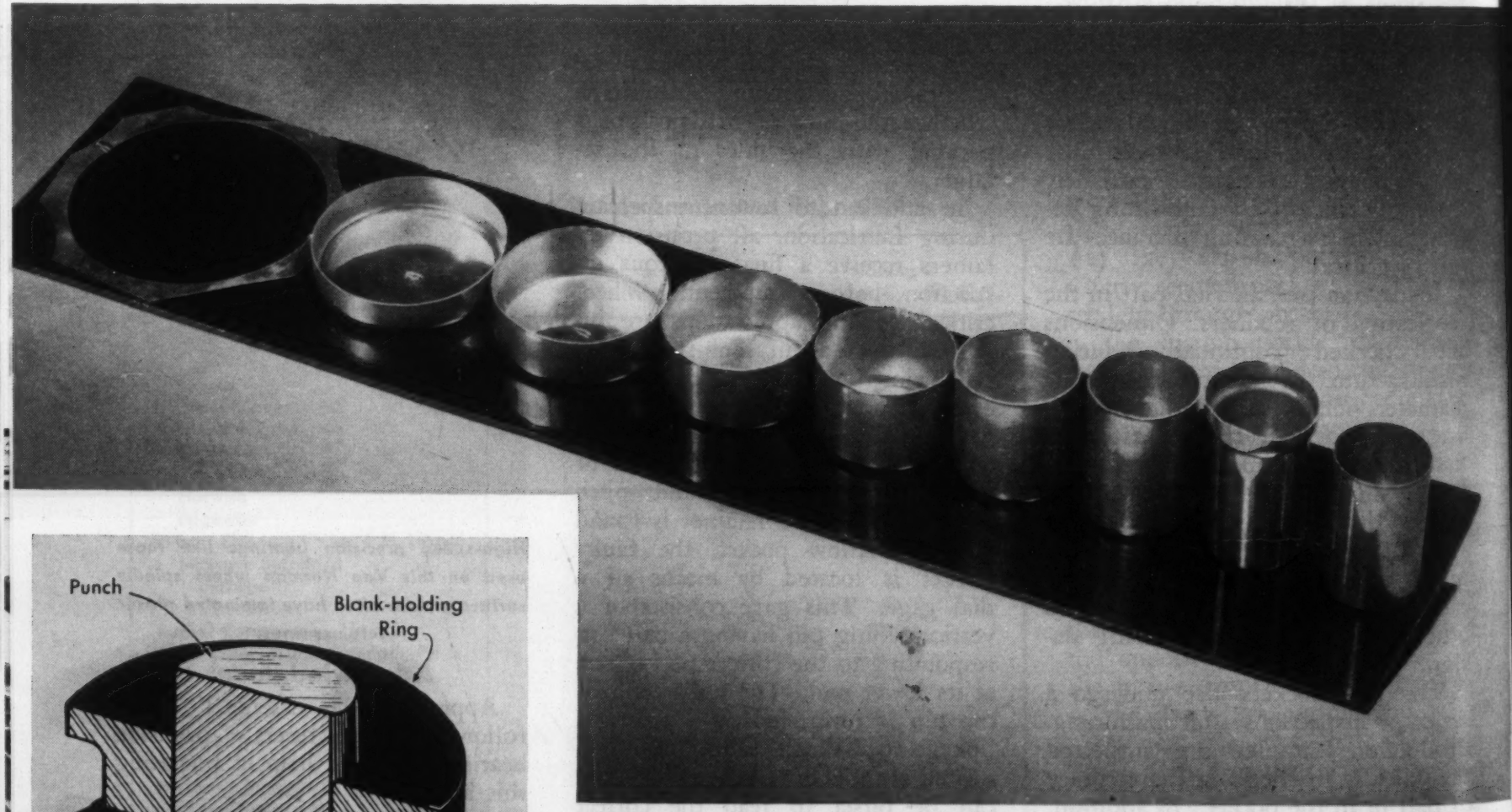
Aetna Ball and Roller Bearing Co.
The Barden Corp.
The Fafnir Bearing Co.
New Departure Div., General Motors Corp.
SKF Industries, Inc.

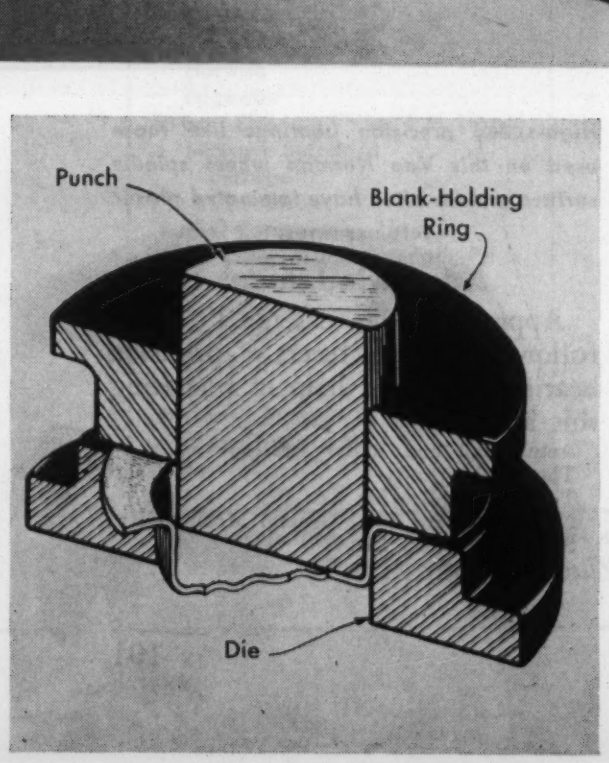
Spun and Drawn Zinc Parts

***SPINNING OF ZINC** is accomplished as shown in sketch. Photo shows stages in the production of a spun dish.*





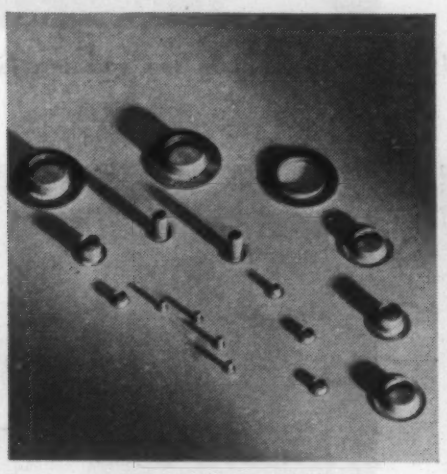




***DRAWING OF ZINC** battery can. Sketch shows typical tooling. Photo shows stages in the progressive drawing process.*

TYPICAL DRAWN ZINC PARTS:

a—Flashlight case and reflector
b—Eyelets and grommets
c—Electric meter box
d—Mason jar top



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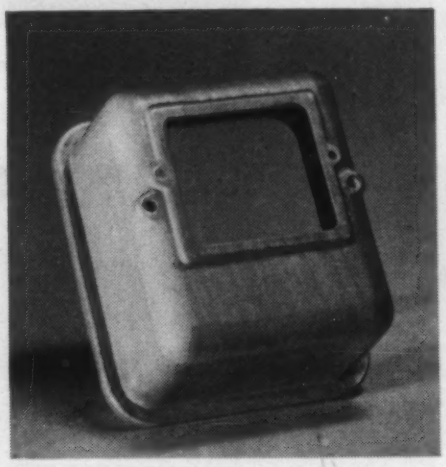

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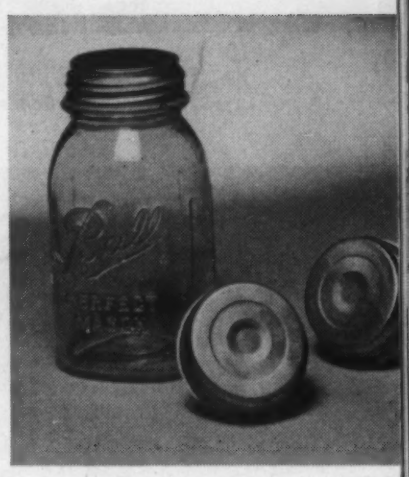

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ts Have Many Applications

by ERNEST V. GENT,
Executive Vice President, American Zinc Institute

Rolled zinc is readily formed into a variety of shapes by spinning and drawing at room temperature.

● ZINC CAN BE fabricated by most of the common manufacturing processes. Although the most familiar method in this field is probably die casting, large quantities of rolled zinc are fabricated into a variety of shapes by spinning and drawing.

Spinning is one of the oldest and most satisfactory methods of shaping zinc into a desired form, but is also the least known. Spun zinc would undoubtedly enjoy much wider use if engineers and designers were better informed of the advantages of this method of production. At present, its applications lie principally in the production of decorative objects. On the other hand, drawing is widely used for the production of battery cans and other industrial products.

Spinning

Spinning is used in preference to other fabricating procedures when (1) the number of parts to be produced is limited; (2) tool costs must be held to a minimum; (3) the design is such that other fabricating methods are not suitable. Thus, it is possible to spin either convex or concave shapes and to obtain vessels with reversed curves.

For the production of a spun part, a circular blank is rotated in a high-speed lathe and forced against a chuck of the desired contour by means of suitable forming tools. A typical tool arrangement is shown in an accompanying figure. Since the metal is formed during the rotation of the chuck, the process is suitable only for the production of symmetrical hollow vessels, but within this limitation a great variety of shapes can be formed. Although the actual spinning operation requires considerable skill in order to apply just the proper pressure in the right manner to form the part correctly, a skilled craftsman can produce parts which are quite uniform in size and appearance.

Rolled zinc flows readily at room temperature and is one of the easiest metals to spin. It does not work harden appreciably, and requires no pre-heating and no annealing between operations. The operation can be divided into three steps: (1) breakdown, in which perhaps 95% of the deformation is obtained; (2) the final 5%, in which the metal is forced to follow the conformation of the form block; and (3) removal of tool marks.

After spinning, the lathe can be employed to secure the desired finish. Thus, after shaping the part, the spinner can decorate the surface with a skimming tool, obtain a satin-like finish with a finishing wheel, or buff the metal to a fine polish. Because of the excellent ductility of zinc, embossing is accomplished readily after these operations, if desired.

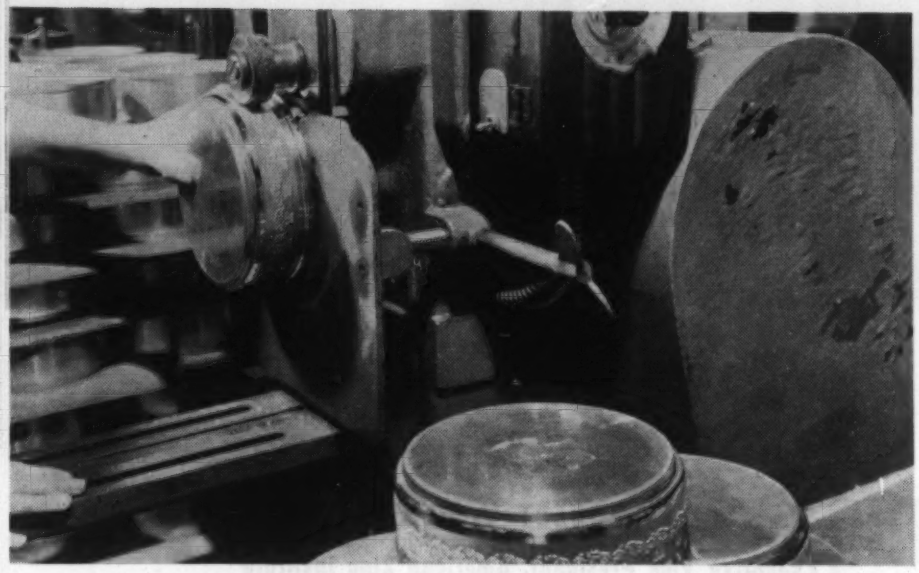
Although spun zinc has many potential applications, the chief uses up to the present time have been for decorative purposes. Among these are containers for various purposes, bezels, lamp bases and shades.

Drawing

Zinc is well adapted to drawing operations. A soft rolled zinc made

1. The spinning of zinc is readily accomplished since the metal flows easily at room temperatures.

2. Skimming in tne spinning lathe produces a decorative effect.



3. Zinc can be embossed easily and rapidly.

4. Spun zinc parts can be finished by spraying with suitable lacquers.

from relatively high grade slab, usually referred to as deep drawing zinc, is used for this method of fabrication. Perhaps the best known of the many products made by drawing rolled zinc is the dry battery can, which is drawn from a blank in progressive operations.

While many of the commonly drawn zinc shapes are achieved in a single draw, using the same or similar drawing practice as employed with other metals, progressive drawing of rolled zinc requires certain modifications if success is to be achieved. The clearance between punch and die on the first draw should be equal to the thickness of the stock, and warm soapy water or a commercial compound should be used as the lubricant. The reduction in diameter in the first stage should not exceed 40% of the diameter of the blank, while succeeding draws should be limited to 20% of the preceding draw. No annealing is required between draws since the grades of zinc usually used are self-annealing at the temperatures developed during drawing.

The production of battery cans consumes many thousands of tons of rolled zinc annually, but many other products are produced in this manner. These include condenser cans, eyelets, grommets, ferrules, flashlight reflectors and cases, meter boxes, rivets, staples and washers.

Requirements for the Progressive Drawing of Zinc

1. The total area of the finished drawn shape is computed and sufficient area is added to allow a trim (generally ¼ in.) on the finished part.
2. The diameter of a blank having the above area is calculated.
3. The reduction in diameter from the blank to the first drawn shape should not exceed 40% of the diameter of the blank. Another way of expressing this is to say that the depth of the first draw should not exceed 45% of its diameter.
4. The reduction in diameter of succeeding draws should not exceed 20% of the preceding draw.
5. Radial clearance between the punch and the die on the first draw is equal to the thickness of the stock. Fillets are usually generous.
6. Warm, neutral soapy water, or one of the commercial compounds, is generally used as a lubricant.
7. Since the purer grades of zinc are self-annealing at the temperatures developed during drawing, no annealing is required between operations.

Finishing

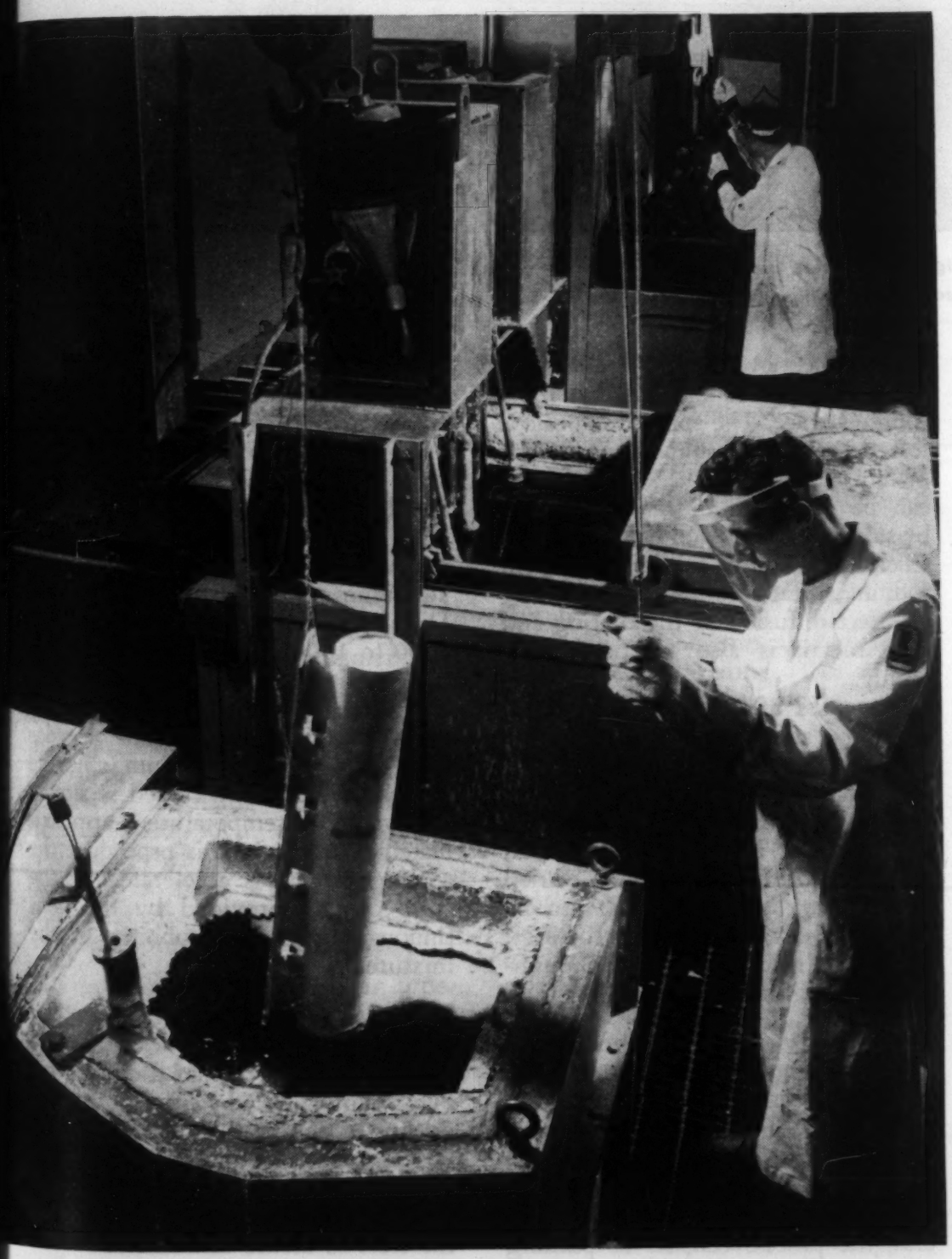
Before electrodeposits, lacquers, enamels or chemical films are applied on rolled zinc parts produced by spinning or drawing, it is necessary, of course, to remove all dirt or grease picked up during fabrication and handling. Rolled zinc can be nickel and chromium plated directly. Brass, copper, bronze, silver and gold should be used over a primary coating of nickel.

In the case of painted coatings, a pretreatment should be used if the surface requirements of the drawn or spun zinc part are unusually severe. Rolled zinc can be finished by brushing, spraying or dipping in the same manner as other metals. Baking or forced drying adds to the adherence and durability of the paint coating. The limiting temperatures for baking vary, depending upon the amount of cold working present as well as the composition of the metal. As a general rule, a 2-hr treatment of 200 to 300 F is safe and gives good results.

Aluminum Coatings Applied to Steel by Many Methods

Choice of coating depends on many factors including (1) the size and shape of the object, (2) appearance desired, and (3) service conditions.

by **E. M. SMITH,** Metallurgical Engineer



***HOT DIPPED ALUMINUM COATING** being applied to a fabricated steel diesel engine exhaust manifold inside and out. (General Motors Research Lab.)*

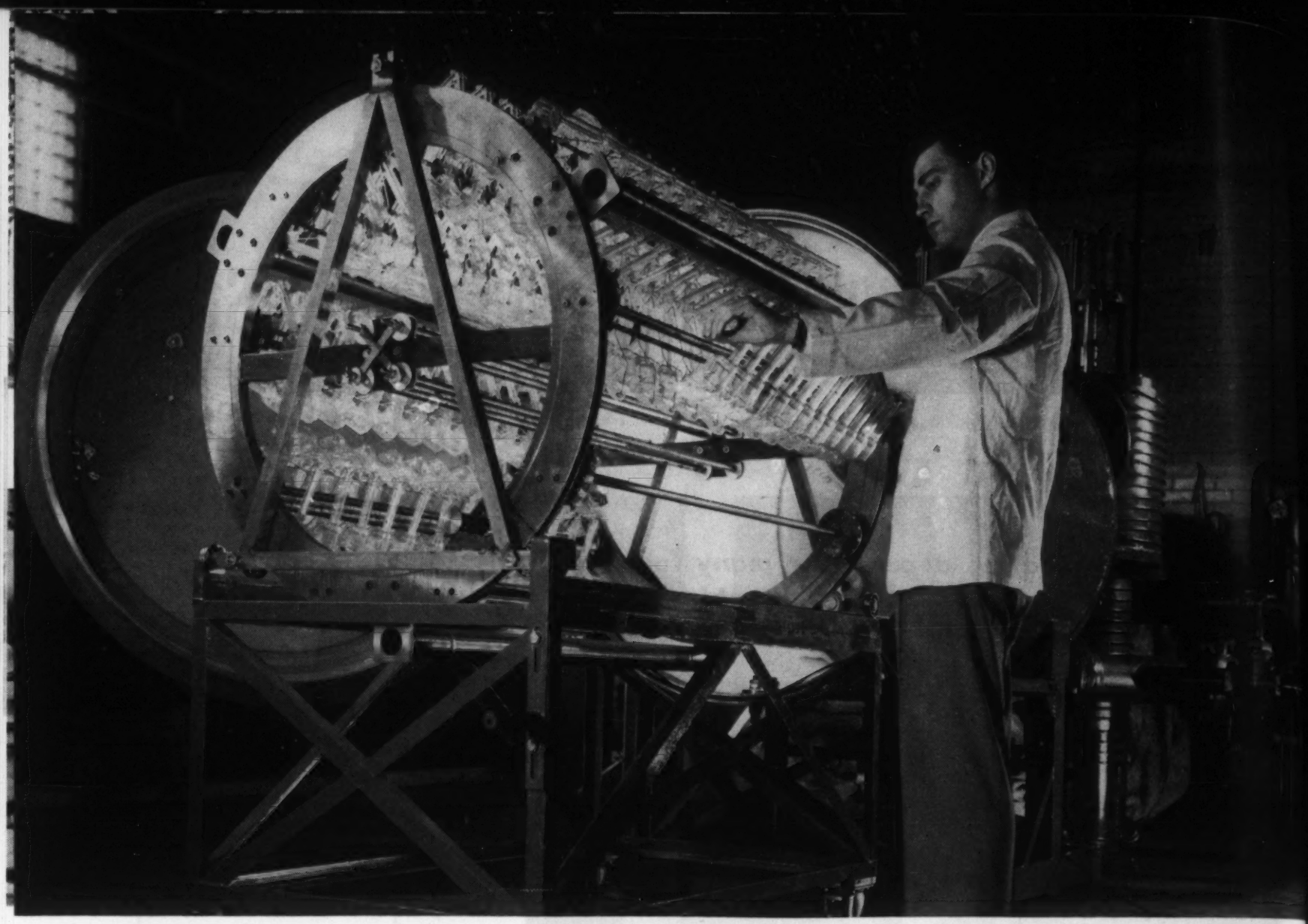
● ALUMINUM COATED STEEL combines the excellent corrosion resistance of aluminum with the strength of steel. It is not a new material, but improved methods of production have increased its availability, and its applications are steadily widening. Also, expermentation and development continue to improve the bond and appearance of the coating and reduce cost of production.

Steel is coated with aluminum by a number of methods. Each has its advantages and its disadvantages in its effect on particular properties. The methods available are: spraying, calorizing, hot dipping, rolled cladding, electroplating and vapor plating.

The choice of the method for applying aluminum to steel depends upon the type of object to be coated. Cladding by rolling is essentially restricted to sheet and strip. Electroplating is restricted to relatively small parts of regular shape. Vapor plating is useful for small parts that can justify the expense of vacuum technique. In addition to the size and shape of the base product, the desired appearance of the aluminum coating limits the methods selected for applying the coating. Sprayed coatings have a matte finish and tend to be whiter in color and rougher than hot dipped coatings, which are smooth and bright.

Sprayed Coatings

In many respects spraying is the easiest method of making aluminum-coated steel. The technique differs little from the usual method of spray coating with lead, tin and solders, and coatings can be built up to any



VACUUM COATED ALUMINUM provides a bright finish. Here parts are being loaded on rack. Coating apparatus and vacuum unit appear in the background (Distillation Products Industries Div., Eastman Kodak Co.)

desired thickness. Sprayed aluminum is attractive in appearance, although it has a dull white matte finish. There is a tendency for the coating to be porous, and sealing with sodium silicate is practiced commonly. Heating after coating causes aluminum to diffuse into the steel, improving the heat and scaling resistance.

To apply the aluminum to the steel, a Schoop metal spraying pistol can be used. Both gas fired and electrically operated pistols are available, and either aluminum powder or wire can be fed to the pistols. In a modification of these procedures, feeding the pistol with liquid metal previously melted in a gas heated crucible has been used. A shot blasted steel surface is desirable to assure good bonding.

The efficiency of spraying depends upon the type of gun used and its distance from the steel to be coated. For a wire pistol held 4 to 8 in. from the surface, Burns and Schuh claim an efficiency of 85 to 90%.

Sprayed coatings, as deposited, do not provide an intermediate layer. The sprayed particles upon impingement flatten into relatively thin flakes, and the impact and flow causes welding of the particles as well as increased hardness. At the same time, overlapping results in pores and cavities and accounts for a rough surface. The sprayed deposit is less dense than cast metal (approximately 2.35 versus 2.70). Porosity can be decreased or made harmless by subsequent abrasion or burnishing. Chemical sealing by immersion in sodium silicate, followed by heating to effect diffusion of the coating and base metal, is also practiced commonly.

The uses of sprayed coatings are numerous and diverse. Mechanization of the processes is possible for straight line production of identical shaped parts. Equipment is portable, and spraying is the only aluminum coating process that can be carried to the work. Spraying can also be useful to salvage defective coatings, sometimes made in the other aluminum coating processes.

Calorizing

Calorizing, similar in technique to pack carburizing, was one of the first methods used to aluminum-coat steel. The method is especially adaptable to large bulky steel articles. In general, the process consists of packing a steel piece in aluminum powder in an atmosphere-tight container and holding the assembly at an elevated temperature until the aluminum diffuses into the steel surface.

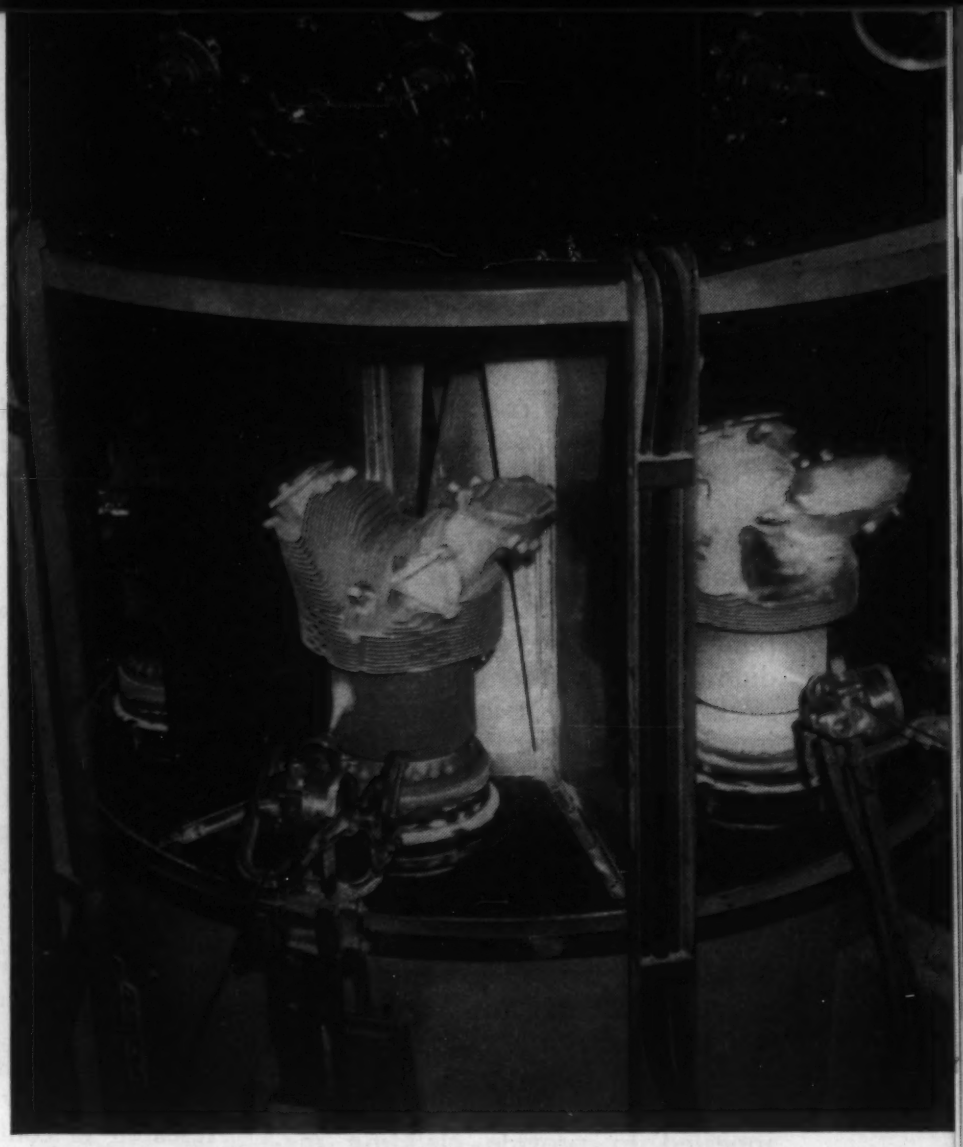
In addition to aluminum powder, some silicon powder can be used so that both aluminum and silicon alloy with the iron. A mixture of aluminum oxide, aluminum powder and aluminum chloride can also be used. Diffusion may require holding at 1700 to 1800 F for one to two days.

For suitably shaped articles a tumbling method can be adopted. A drum containing aluminum powder with 1 to 5% ammonium chloride and the pieces to be coated is slowly revolved. The temperature is approximately 1700 F. In this procedure the coating process is accelerated by the close contact provided by the continuous impact and rubbing in the mixture.

Hot Dipped Coatings

A thorough review of the literature on aluminizing by the hot dip method indicates that major difficulties arise from: (a) the difficulty of maintaining an oxide-free surface on the coating bath; (b) preparation of the steel to assure uniform and complete wetting by the molten aluminum; (c) prevention of oxidation of

ELECTRODEPOSITION OF ALUMINUM from an organic bath at room temperature is conducted in a closed container to avoid the introduction of moisture by a process developed by Dwight E. Couch and Abner Brenner, National Bureau of Standards.



SPRAYED ALUMINUM COATING being applied to aircraft engine cylinders for corrosion protection. (Metallizing Engineering Co.)

the steel surface during immersion into the molten metal. A number of devices and techniques have been developed to overcome these difficulties. Hot dipping provides the only commercial method presently feasible for production of aluminum-coated strip and wire.

At the present time strip and wire are being coated commercially by methods patented by Sendzimer and Oganowski. The surface of the aluminum bath is protected from oxidation by an inert or reducing gas. Preparation of the steel for coating is accomplished by oxidizing the surface and then reducing it in an atmosphere containing hydrogen. After this treatment the strip or wire is protected from exposure to the air until it is introduced into the coating bath.

A hot dip aluminum coating process was demonstrated at the 1947 Metal Show by the Upton Electric Salt Bath Furnace Co. In this salt bath process, degreased and descaled steel is pre-fluxed in a molten salt and then immersed for approximately 15 sec in a salt bath containing molten aluminum. In the latter, the salt serves as a heat transfer medium and also as a cover flux. A Swedish method advocated by Goran Moller uses molten barium chloride upon which molten aluminum floats. Thus, the steel can be lowered through the molten aluminum into the salt for fluxing and then raised and held in the aluminum for the desired coating time.

When coating by the salt bath method, it is imperative that residual flux be removed from the coating. It is difficult sometimes to obtain a smooth even coating free from depressions or irregularities. The density of the salt flux is so close to that of molten aluminum that the molten salt retained on the coating may cause indentation of the aluminum coating during freezing. Except for appearance's sake, this disadvantage of the process is of little moment. In other respects, the coatings are lustrous and attractive. Other salt bath furnace companies are reported to be actively engaged in investigating the commercial possibilities of such coating methods.

Hot dip coating methods have been developed that dispense with the use of inert atmospheres and salt fluxes. These newer methods have proved quite successful for complicated shapes and formed parts. Whitfield and Schesunuff have described the coating of steel aircraft cylinders with aluminum. Gears having a steel hub with an aluminum rim and machine cut teeth have been made by similar methods. Furnace parts and small fittings can also be made. Thorough cleanliness, care in preparation and proper immersion techniques are essential for the production of suitable aluminum coatings. However, the methods are available and will be used more widely as the processes become better known.

Pontiac cars for some time have been using aluminum-coated tail pipes in an attempt to overcome corrosion difficulties. Such products are coated without the use of special atmospheric protection.

Enthusiasm over the potentialities of the aluminum coating of steel wire is steadily mounting. Recently, Lewis mentioned promising developments in the early pilot plant stage. He claimed the protection potentiality of aluminum greatly exceeds that of any other metal including zinc.

Roll Clad Coatings

German technologists have produced rolled-on aluminum coatings for steel. Commercially, the product is known as Feran or Feral. In this

process, aluminum and steel are bonded together by application of temperature and pressure during hot rolling. The method is adapted to high-speed production of clad material. Subsequent cold rolling can be employed to work harden the material.

More recently, a patent has been obtained for cladding steel with aluminum foil. Iron is electrodeposited on the steel to provide a pure iron interface and bonding medium between the aluminum and steel. About 0.0001 in. of electrolytic iron is sufficient for the purpose. The steel is heated to 900 F in a non-oxidizing atmosphere and is hot rolled between two aluminum foil or sheet surfaces for bonding.

The steel composition is 0.06 carbon, 0.04 sulfur, 0.04 phosphorous, 0.06% manganese and traces of silicon. Aluminum containing 0.6 to 1% silicon and 0.5% iron hot rolled into strip 6 in. wide and 0.25 in. thick is cold rolled to 0.008 in. and annealed to provide cladding material. Steel 0.014 in. thick is cleaned, pickled, rinsed and lime-coated by dipping in warm chalk water. After roughening the surface by scratch brushing, the steel is fed into a rolling mill between two layers of aluminum. The heat required for good adhesion is said to be provided by the rolling operation itself. No external heating is required. The strip of aluminum clad steel is wound on the exit side of the "sticker" mill under high tension. Additional cold rolling produces the desired gage. Final annealing at a temperature of 995 to 1025 F for 10 to 15 hr completes the process. Annealing time and temperature affect the flexibility of the strip and the thickness of the compound at the interface between the two metals. Feral has been used in Germany in the manufacture of flexible tubing, electric cable wraps and telephone diaphragms.

Electroplating

Less progress has been made with electroplating aluminum on steel than with other methods. Plating from an aqueous solution has been unsuccessful and the method has been abandoned. Nonaqueous media are now being investigated and some electrolytes claimed to be suitable for aluminum plating have been patented. Among the electrolytes which have been proposed are:

1. Tetraethyl ammonium bromide and aluminum bromide.
2. A metal-alykl-iodine complex or etheral solution of an aluminum complex of the grignard type.
3. Benzene and its derivatives plus alkyl or hydrogen halides and aluminum halides.
4. N-alkyl pyridium chloride or bromide and aluminum chloride.
5. Aromatic compounds (toluene or benzene) added to N-alkyl pyridium chloride or bromide.

The electroplating of aluminum on steel has so far been restricted in its applicability. It is essential that the plating solution be isolated from the atmosphere to avoid hydrolysis. The plating rate is relatively slow and the size of the articles which can be plated is small. Economically, electroplating is expensive and is used only on parts that cannot be aluminum coated by other means.

Aluminum plating is still somewhat of a laboratory curiosity. However, research is continuing and progress has been made toward increasing the rate of plating and the adherence of the coating.

Vapor Plating

The evaporation method has proved quite adaptable to the deposition of bright, highly specular overlays of aluminum. Reflectors for sealed beam headlights are made in this manner.

The basic principles of vacuum coating determine the type of equipment required. A container similar to a bell jar of sufficient capacity to surround the part or parts to be coated is placed upon a base which will permit a vacuum-tight seal. The surface to be plated is positioned in such a manner that it is in direct unobstructed line with a common point from which the aluminum is to be evaporated. After the container is evacuated to a high vacuum (0.1 micron), the aluminum is vaporized in a high voltage arc. The aluminum vapor deposits in a thin uniform layer on every surface directly facing the source.

Standard units providing an evacuated volume 48 in. in dia and 48 in. high are available. As an indication of the economic feasibility of the process, the production of lustrous barrettes and costume jewelry for sale in ten-cent stores may be cited.

Larger units can be obtained. Besides arc vaporization, resistance heating at low voltage and high current or induction heating can be used. A modified design provides a means of coating long rolls of steel strip. Tolansky states that slow sputtering rates make such coatings economically impractical and thermal evaporation is preferred.

Volatilized aluminum chloride circulated about the ferrous material at a temperature sufficient to effect a reaction of the metal and the vaporized salt has also been proposed. A smooth, light grey coating forms, which is suitable for heat resisting applications.

Applications

One of the common uses of aluminum-coated steel is in fire wall construction. The aluminum coating not only serves as a reflector of radiant heat, but also offers improved scaling resistance in the medium temperature range. Aluminum has a relatively high electrical conductivity compared with steel. Thus, high strength electrical conductor and shunt material is a distinct possibility. Because of the lower specific heat of steel, aluminum- coated steel has a greater heat transfer efficiency than aluminum alone. Hence, the material is used for making cooking utensils and heat exchange equipment.

Bearings are made of aluminum-coated steel for special applications because their cost is lower than conventional sleeve type bearings. Use of aluminum-coated structural steels in greenhouse construction as a defense against humid exposure and in outdoor construction work for protection against atmospheric corrosion is under consideration. Because of the excellent corrosion resistance and high strength of the composite material, numerous additional uses for aluminum-coated steel can be expected in the future.

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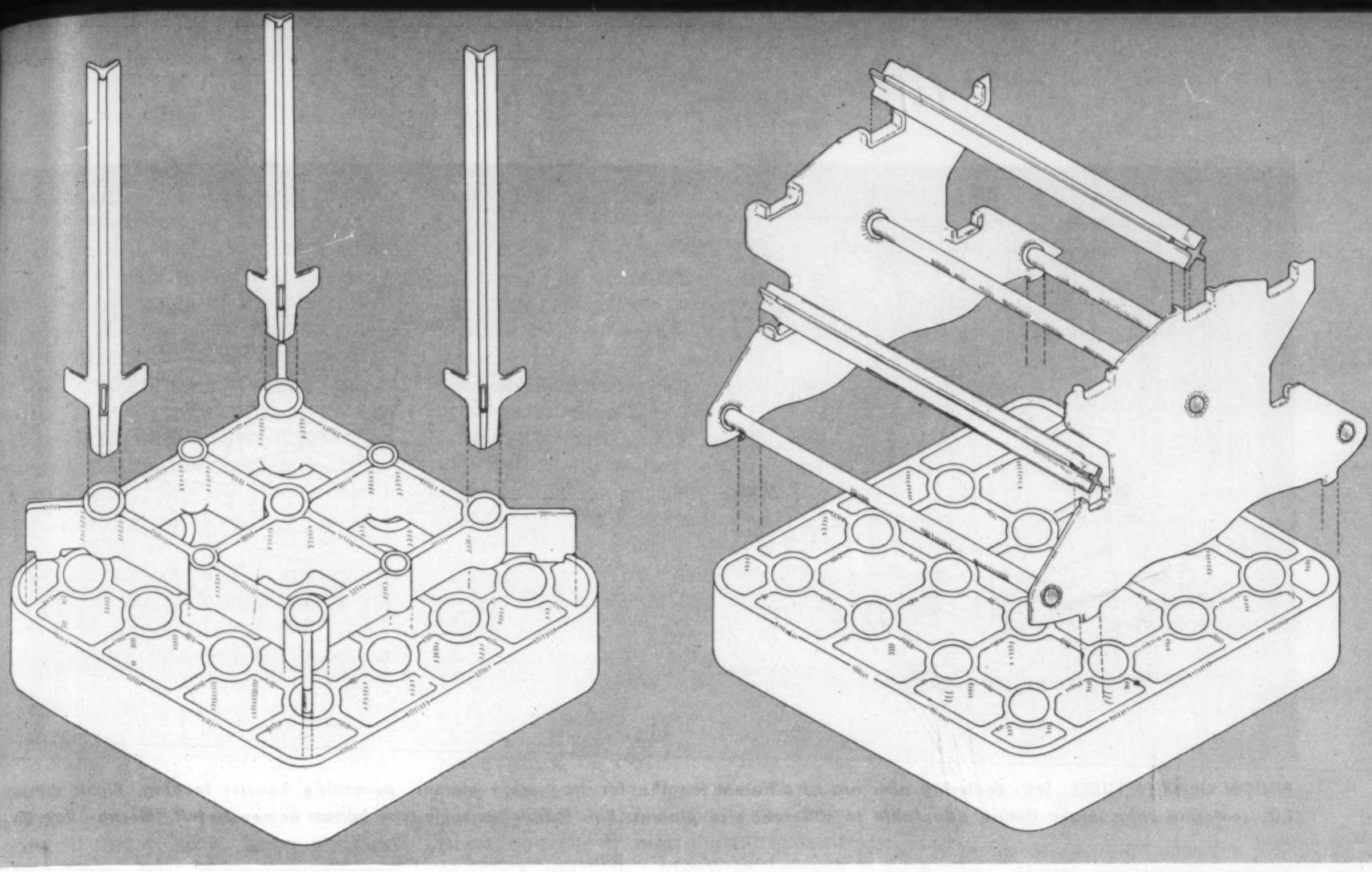


BASIC TRAYS (bottom) are designed to handle wide range of sizes and shapes. Left: spider with vertical pins fits over tray to handle parts without projecting beyond tray edges. Right: beam supports fitting on side frames are useful for bored pieces. (General Alloys Co.)

Versatile Fixtures for High Production Gas Carburizing

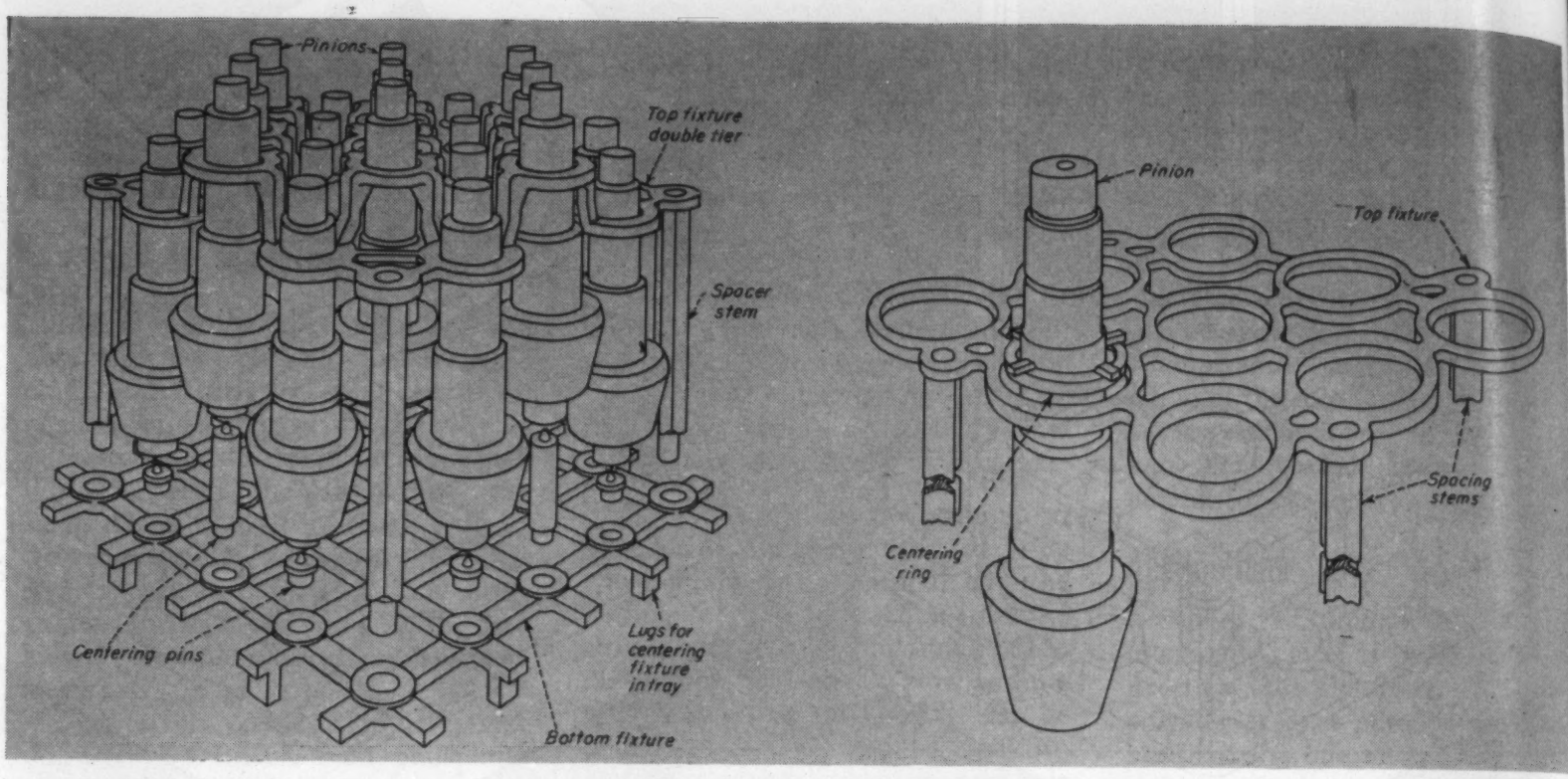
by **T. A. FRISCHMAN**, Chief Metallurgist, Axle Div., Eaton Manufacturing Co.

Camshafts, gear shafts, bored pieces and other complicated parts of many different sizes are efficiently handled. Treated parts meet close tolerances and high standards of quality.

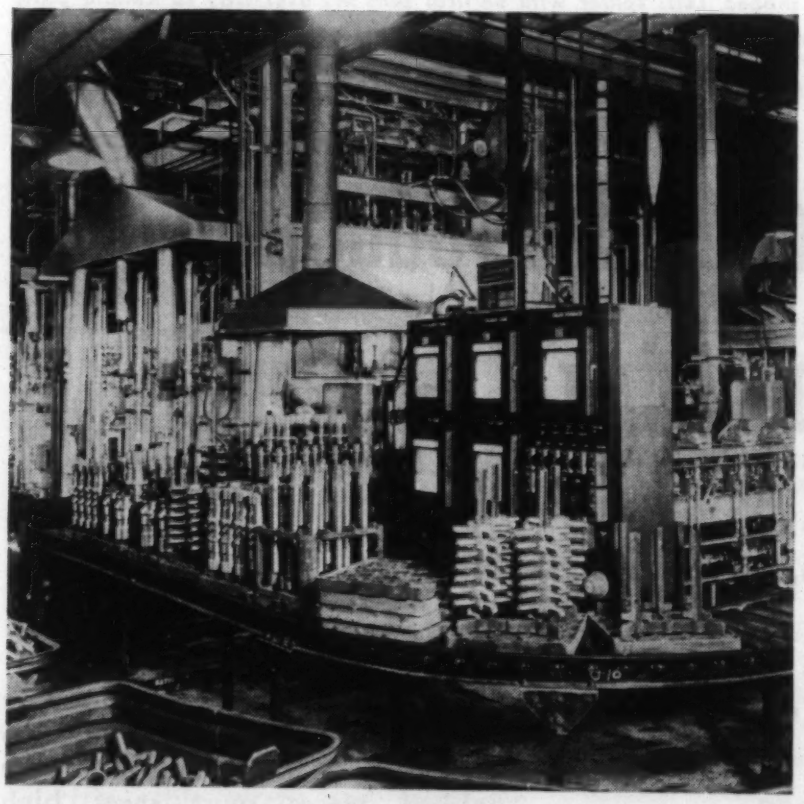
● GAS CARBURIZING of steel parts requires careful support of the workpieces to minimize distortion during the relatively long heating time, and to prevent blanketing of portions of the work. This is most easily accomplished in rotary carburizers, where the motion of the hearth brings about constant change in the position of the work. Many types of pieces are not suited to carburizing in rotary furnaces, however, and for such parts as gears, shafts, rods, and the like, other methods must be provided.

The use of trays provides a means of controlling the position of the work, of loading and discharging automatic or semi-automatic furnaces, and of keeping a record of the pieces going through the furnace. Alloy baskets are especially suitable for use with gears and similar objects of simple shape. When the pieces to be carburized in gaseous media include camshafts, gear shafts, and other parts of complicated design, more elaborate devices must be used to support them in the furnace if the finished pieces must meet high standards for dimensional tolerances and metallurgical quality.

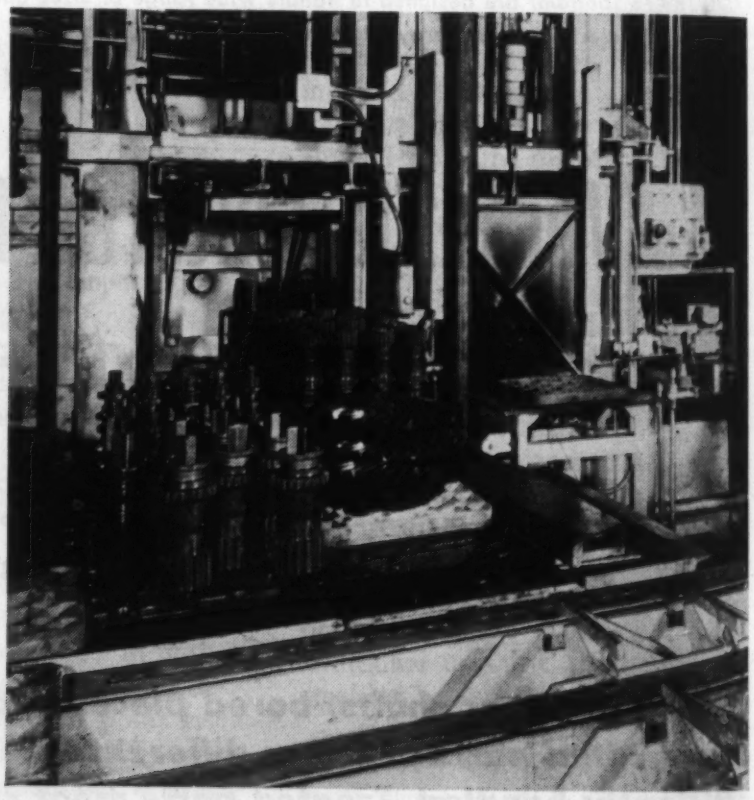
In the heat treating departments of mass production industries, such as automotive plants, this problem can be met simply and efficiently by designing a fixture of light weight and high capacity for each piece or for all of a group of similar pieces. Where the carburizing furnace is built into a production line, and takes only one, or at most only a few types of parts for months at a time, there is no need for versatility. The job shop, at the other extreme, requires utmost versatility in its fix-



PINION GEAR FIXTURES. *Left: centering pins are of different lengths for staggering pinions, permitting heavier loading. Right: different I.D. centering rings make fixture adaptable to different size pinions. This fixture has same type bottom as one on left. (Electro-Alloys Div.)*



LOADED FIXTURES *show the wide variety of parts that can be handled. (Surface Combustion Corp.)*



GEARS AND PINIONS *coming out of furnace. (Surface Combustion Corp.)*

tures, even when furnace capacity must be sacrificed.

Versatility and Efficiency Required

At Eaton Manufacturing Co. the equipment for carburizing is required to be both versatile and highly efficient. Very large quantities of each carburized piece are processed while at the same time many different pieces must be handled by the carburizing equipment. This need for both versatility and high production has controlled our selection of furnaces and fixtures. Carburizing furnace fixtures used are all of 35 nickel-15% chromium-alloy steel, and even when the fixtures are designed for greatest versatility, the minimum equipment for a single furnace will cost many thousands of dollars.

Versatility begins with the carburizing furnace itself. The newest of these furnaces at Eaton's Axle Div. plant in Cleveland, and the one selected to illustrate the combination of versatility and high production, is a four-line, radiant tube gas-fired unit with closely controlled carburizing atmosphere supplied from generators located near the furnace. It has a capacity of 900 lb of metal, gross weight, per hour at a standard 14-hr cycle producing 0.050 to 0.065 case depth. Pusher loading is

automatic after the filled tray has been placed at the loading platform and the cycle started. Rate of travel of the trays inside the furnace in a given line can be varied independently of the speed of the others, so that separate time cycles can be used simultaneously to give several different depths of case from the same atmosphere. These cycles are set automatically on the control panel.

Quenching is automatic into circulating oil in the furnace quench tank, but the controls permit bypassing the tank with any tray. The by-passed tray of parts is moved to a discharge platform adjacent to the end of the furnace and the pieces are manually removed for pressure quenching. Four Gleason machines, located at the discharge end of the furnace, are used for the pressure quenching of large gears and similar pieces.

Pieces to be carburized include gears of many sizes, several styles and sizes of brake camshafts, pinions, splined-shafts, rods, and small parts. In general, for fixturing in the furnace, they can be classified into three types:

1. Bored pieces. These include all parts that can be strung onto pins, such as gears. The pins can be used vertically or horizontally, depending upon the nature of the piece and the requirements of the application.

2. Rods and shafts. Included here are camshafts, drive pinions, king pins, splined-shafts, and all sorts of pieces that are best placed in a vertical position.

3. Miscellaneous pieces. These are pieces that require special positioning, on trays or in racks, sometimes by simple stacking with spacers, sometimes by special fittings. They range all the way from large ring gears to variously shaped smaller pieces.

Separable Fixtures

The first economy in fixturing for the heat treating of such a miscellany comes with the use of separable fixtures fitting onto standard trays. This reduces the amount of costly alloy that must be tied up in fixture inventory, and simplifies replacement. The trays, being in constant use, have a shorter life in some cases than the fittings used with them. The best design for the basic tray is one that will permit inverting it every few trips, to avoid center sagging. The trays are socketed to (1) permit use of vertical pins, (2) for attachment of corner posts of grids, (3) for centers for support of shafts, and (4) for lugs of other fittings.

The use of vertical pins for holding strings of bored pieces is so general that it warrants little discussion. Pins fit into sockets in the basic tray, and their number and position is determined by the size of the workpieces. The number and location of the sockets in the basic tray is a matter for individual preference, but three rows of three sockets each permit considerable flexibility in arrangement. The range of possible locations for the socketing is further extended by the use of a spider, fitting over the basic tray and providing for a smaller number and different arrangement of sockets. This is useful when workpieces must be carburized that have projections, such as spiders or similar pieces, that cannot be effectively placed on the standard arrangement on pins without projecting beyond the tray edges.

Pins are available in several lengths. A 12-in. and a 17-in. length make a useful range. The best cross-sectional shape for combining economy of material with rigidity is the 120-deg Y-form. The 90-deg X-form is somewhat more rigid, but is heavier in the same size.

When bored pieces must be held on beam-type supports, a versatile fixture consists of the basic tray, on which is mounted, by lugs, a fitting consisting of two side frames with provision for five detachable beams, two at each end and one at top center. With small pieces, all five beams can be used. Larger pieces may permit the use of only three beams, while for pieces of still larger diameter only the single center beam may be usable. The beams are usually X-form in cross-section. In contrast, shafts and rods are usually placed in a vertical position for carburizing.

Positioning of Pieces

Because many of these pieces are made with a pinion gear or cams attached to or integral with the shaft, the positioning of the shaft is sometimes rather complicated. Some heat treaters insist that the heavy end—that is, the end to which the gear is attached—must be down during carburizing or other heat treating, while others demand that it be up. Still others are concerned only with the results of final inspection, and will accept any positioning that produces satisfactory work. If the requirements dictate some particular positioning of the pieces during carburizing, the grid must be adjustable to accommodate all the pieces of that and similar types for which it may be needed. Even with the greatest degree of flexibility that can be obtained in any one grid, it is good practice to have several types of grid fixtures available. To hold the workpieces in a vertical position, grid fixtures are used, with the grid being supported on corner posts that are socketed into the basic tray. The lower ends of the shaft-type workpieces are supported on pointed pins, or centers, that fit into sockets in the basic tray.

The height of the grid can be adjusted by using spacers in the corner posts to change its position by any predetermined amount. If the pieces to be carburized are shafts with gears or cams attached, a considerable saving in space can be achieved by staggering the position of the pieces—that is, placing them with heavy-end up and heavy-end down alternately, freedom from distortion permitting. It may be necessary to use several different types to obtain high production if a considerable variety of work must be put through the furnace.

The pointed pins, or centers, used to support the lower ends of the shafts and rods in the grid fixtures can be adjusted to various heights by use of spacers in the same way as with the corner posts. They do not necessarily have to be made from heat resisting alloy steel but can be made from ordinary low carbon constructional steel.

No types can be set up for the miscellaneous parts, which may be of such size or of such complicated shape that they cannot be hung on pins or supported in grids. Large gears, for example, may be stacked on trays, with triangular spacers between them; pieces of complicated shape can frequently be stacked, nestled, wired or otherwise placed without blanketing. At times, special fixtures are a necessity.

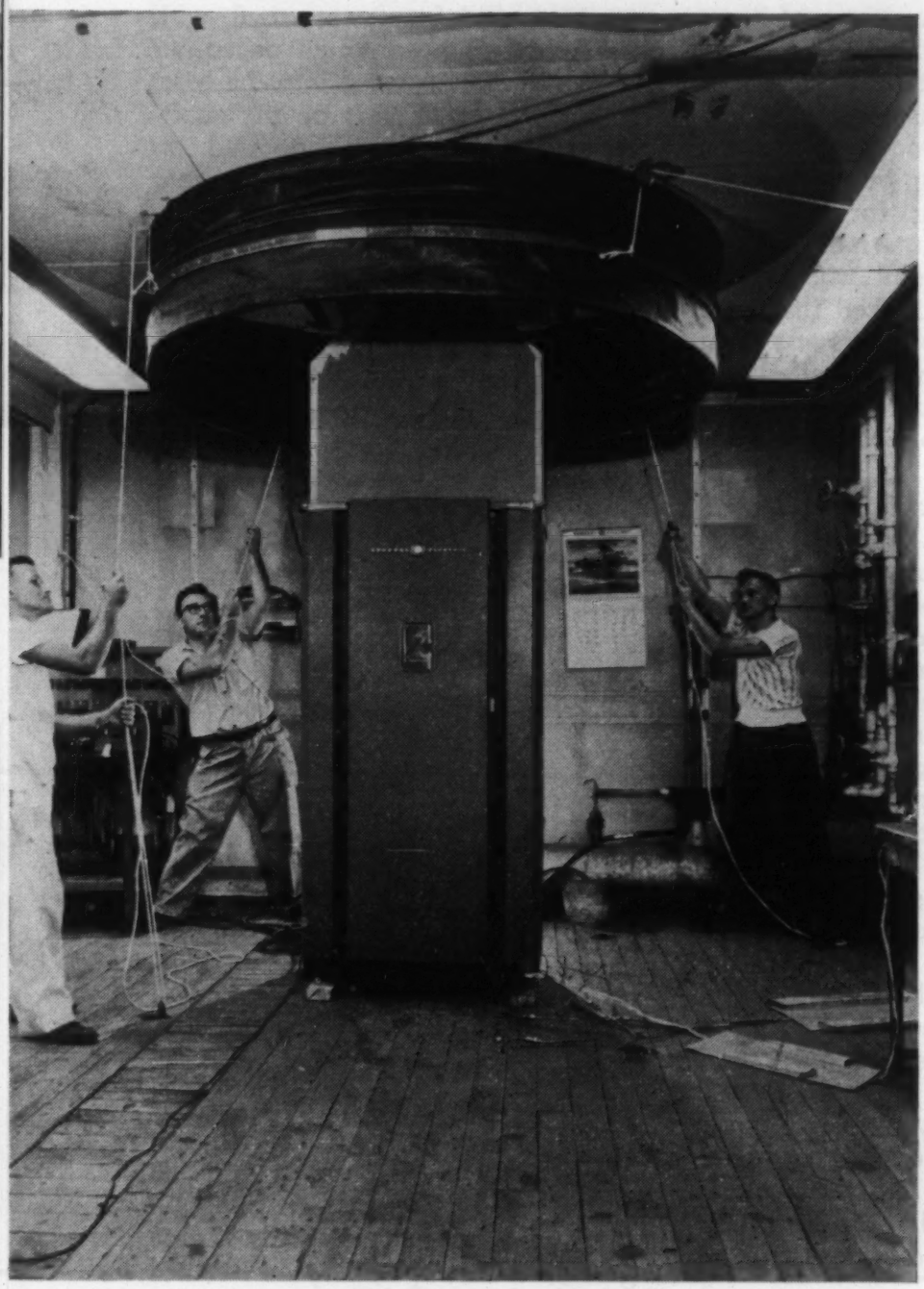
The basic trays, which undergo the hardest service, have an average life of about 6000 hr. Washing the fixtures after oil quenching probably lengthens the life of all parts by reducing the amount of carbonaceous material in contact with the alloy, and especially by removing the small amount of sulfur in the oil.

Materials at Work

Here is materials engineering in action . . .

New materials in their intended uses . . .

Older, basic materials in new applications . . .

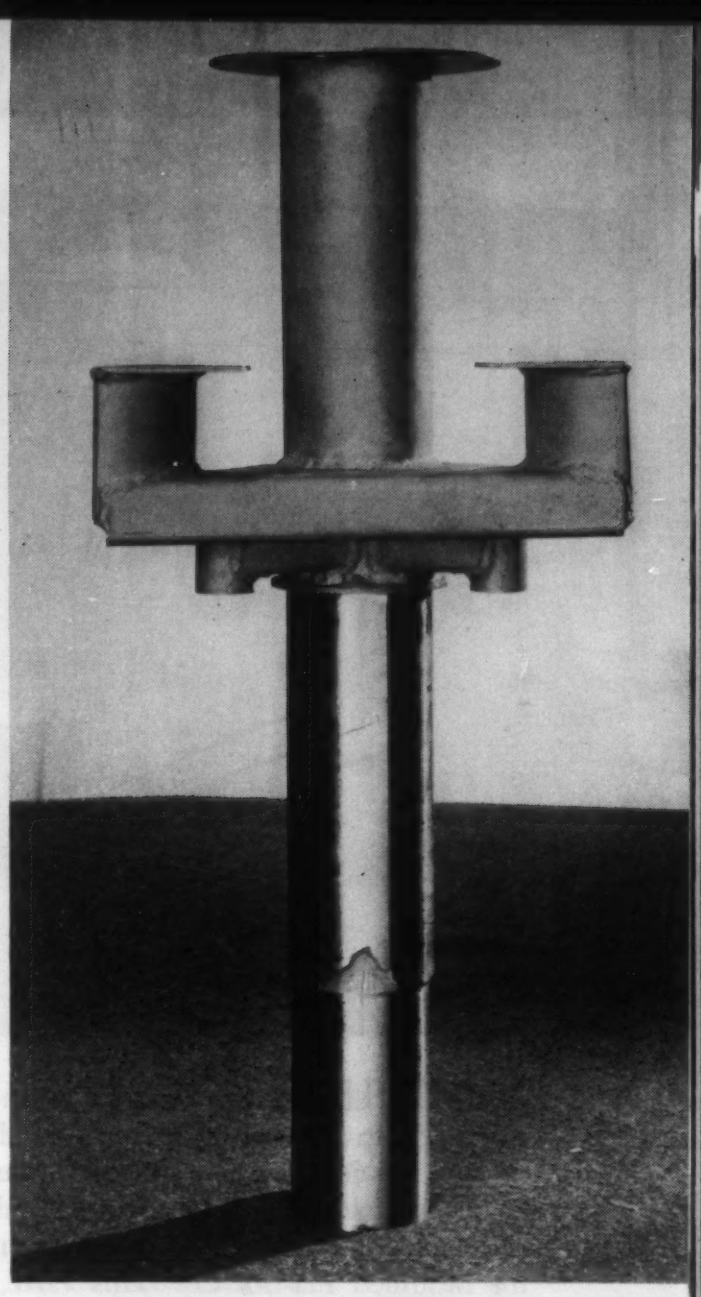


FLEXIBLE TUBING HOUSING The largest piece of flexible tubing ever made has been fabricated by Flexible Tubing Corp. for the Development Laboratories of the Air Conditioning Div., General Electric Co. The tube will be used as a psychrometric calorimeter to test self-contained air conditioners.

Here's how the 7-ft dia, 10-ft 2-in. tube works: The upper end of the enclosure is secured to the test room ceiling and the lower end drawn up. The air conditioner to be tested is installed underneath, and the tube enclosure is lowered and secured to the floor. This forms a room within a room about the air conditioner.

The light weight, easily retractable enclosure is made from moisture and vapor proof Neoprene impregnated duck supported by spring wire 0.244 in. in dia. The window in the side is framed with aluminum for greater strength. The result is an accurate, efficient, highly economical psychrometric calorimeter easy to install and simple to dismantle.

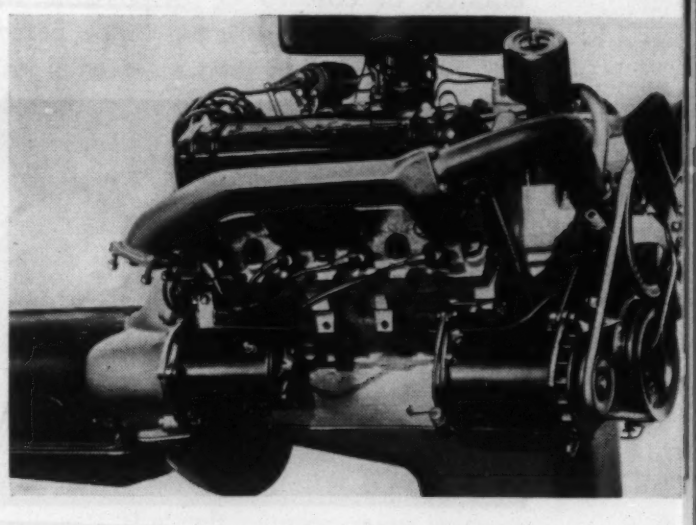
The enclosure and accompanying equipment meet American Society of Refrigerating Engineers testing specifications in all details. With it, G-E Engineers can account for better than 98% of the heat and moisture entering the conditioner.

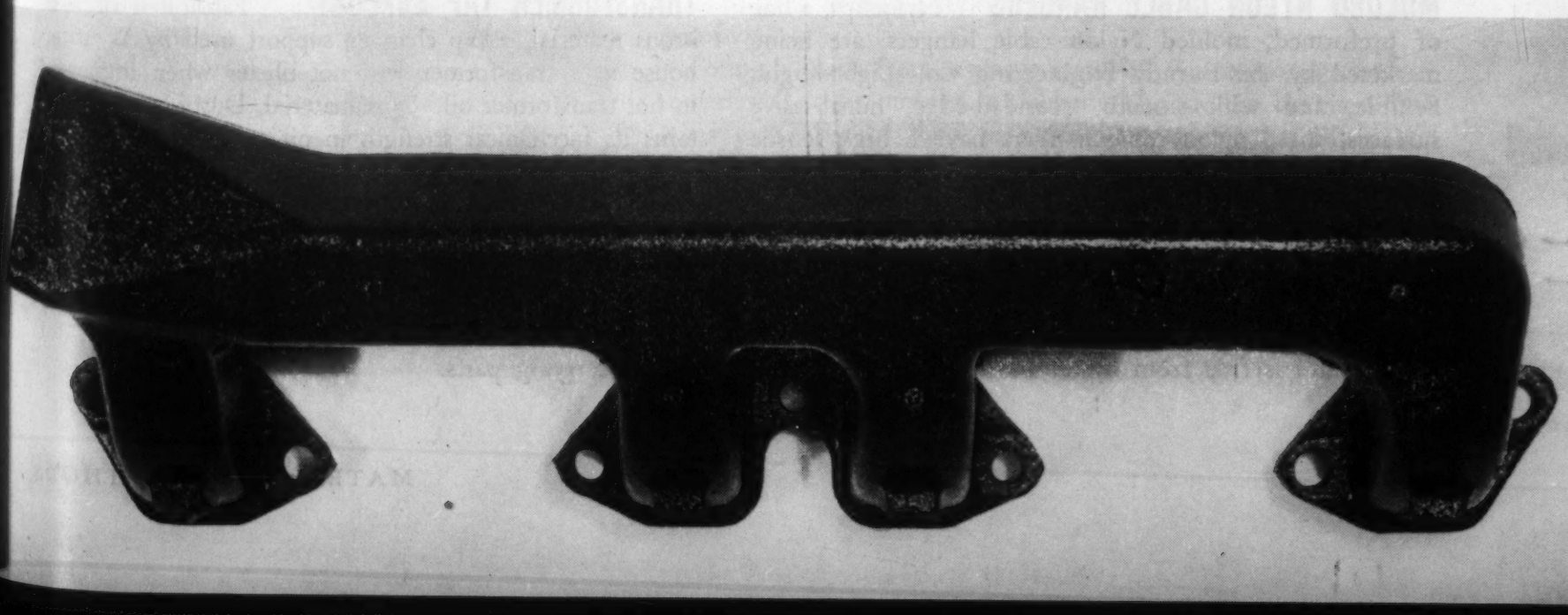


PRECIPITATION HARDENING STAINLESS STEEL AIRCRAFT PART

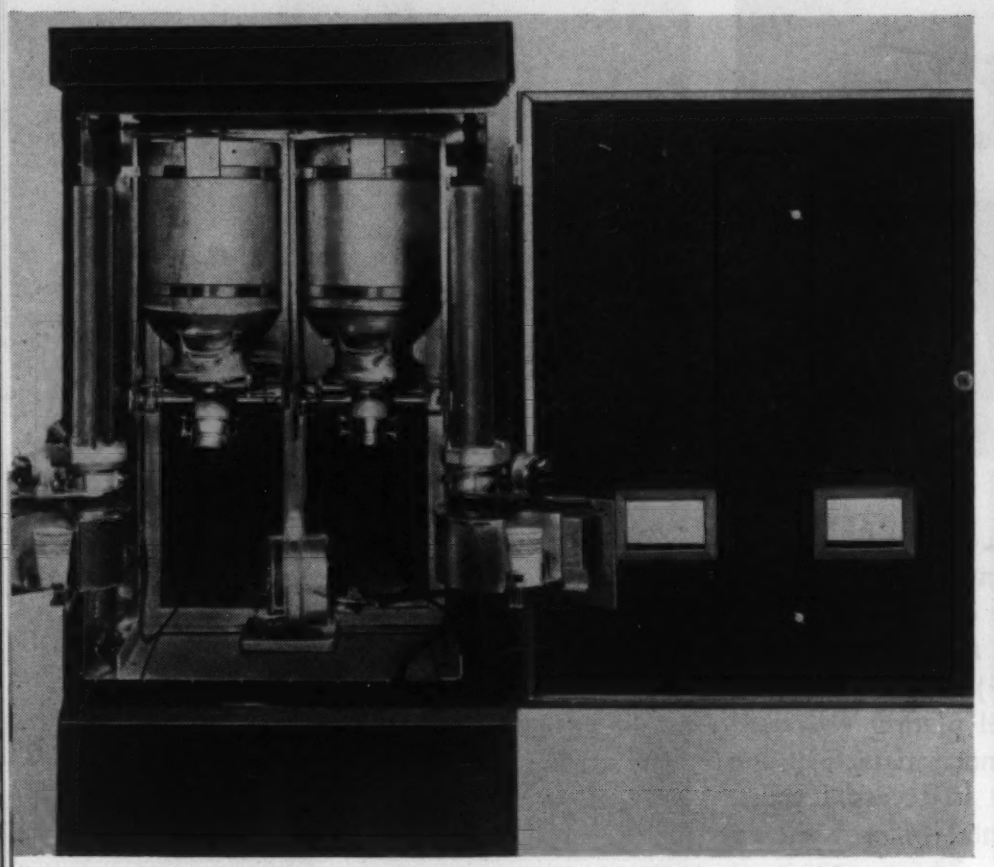
This bollard is located in the nose of the Martin P5M-1 Marlin flying boat. The bollard is used to secure a rope or cable when the ship is at rest on the water. It was originally made from a low alloy steel (4130 chromium-molybdenum steel) heat treated to 180,000 psi. A protective coating of hard nickel plating was used to prevent chafing and rusting. This finish was not satisfactory due to the failure of the plating to coat uniformly in recessed areas, which led to extensive rusting. The experimental bollard shown is made from Armco 17-7 PH stainless steel. The assembly is welded by the gas-shielded tungsten arc process. After assembly, the part is hardened, by means of a precipitation heat treatment at low temperature, to a tensile strength of 185,000 psi minimum. The combinaion of weldability, high strength and excellent corrosion resistance of the 17-7 PH steel fits it admirably for the application.

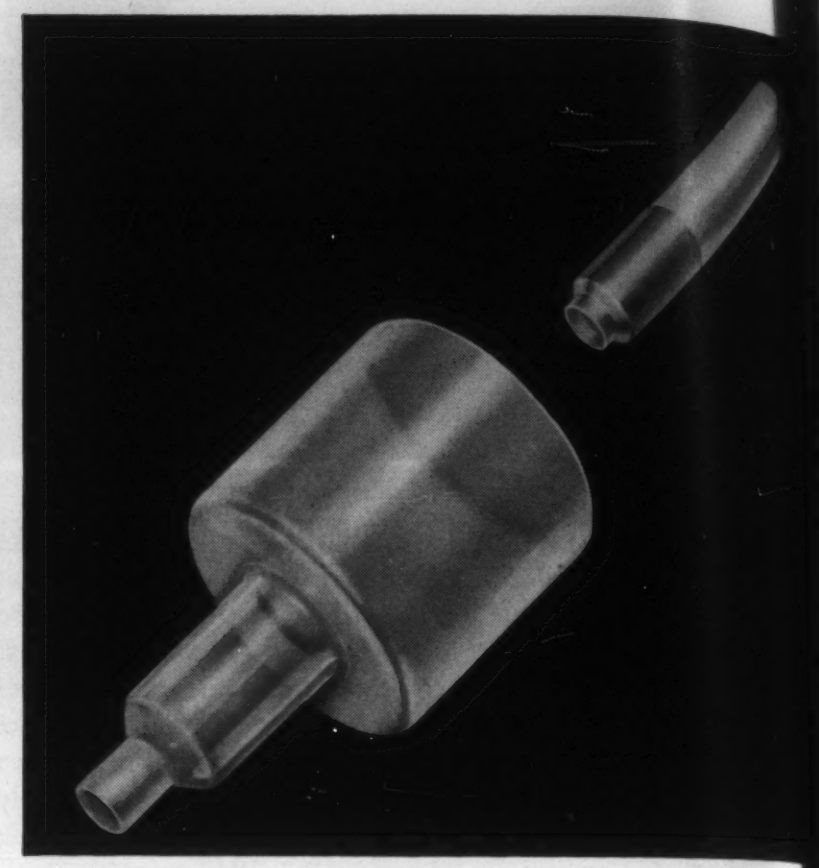
SILICONE MANIFOLD FINISH The manifold on the average automobile loses its new appearance in a relatively short time. The extremely high temperature to which the paint on a manifold is subjected results in unsightly dulling, film deterioration, loss of adhesion and corrosion. Until now, there has been no organic protective coating developed to withstand such high temperatures. Lincoln Engineers, experimenting with various heat resistant finishes, discovered that Sicon Black 7x933 heat resistant silicone-base finish maintained its appearance, color and film integrity, under these operating conditions. Under laboratory conditions, a coated manifold was subjected to 1000 F for 24 hr—a test substantially more severe than actual operating conditions. The finish is supplied by Midland Industrial Finishes Co.





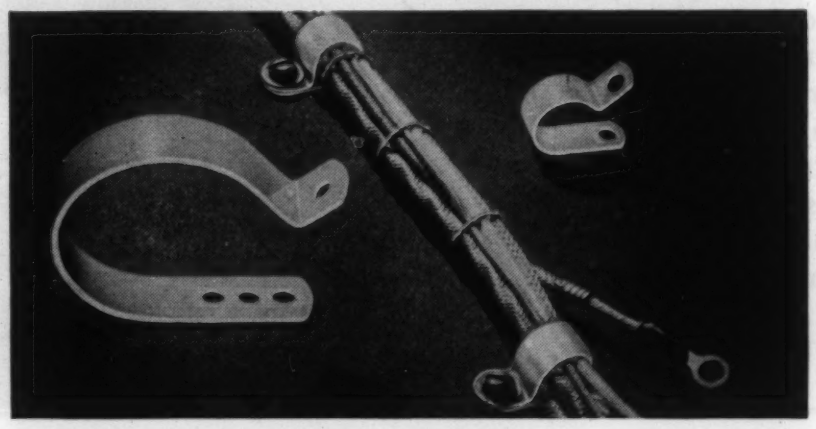
Materials at Work



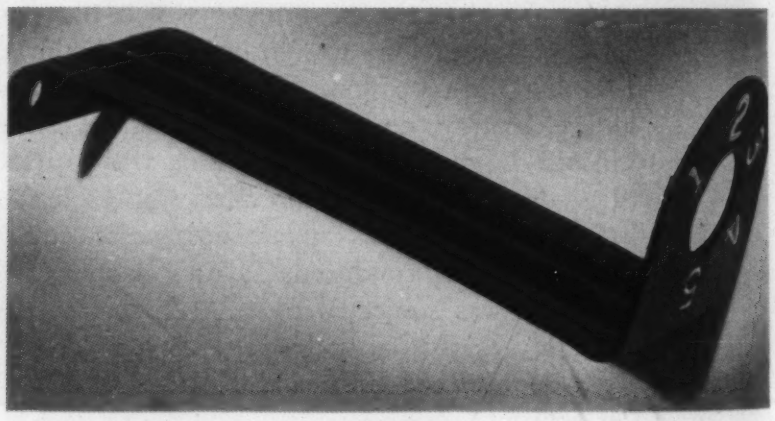


POLYETHYLENE MILK VALVE The problem of vending milk in an automatic milk vending machine, after 4 years of design work and extensive field trials by the Food Engineering Corp., was solved primarily by the development of a polyethylene valve molded by Worcester Moulded Plastics Co. This valve, of course, had to meet Federal, State and municipal sanitary regulations. Worcester Moulded Plastics was called upon to produce a plastics valve which not only would conform to such laws, but would be efficient and foolproof, yet low enough in cost to be dispossable. Actually, the valve has already proved to be, in many cases, more economical than hand washing and sterilizing. The valve operates by magnetic force, without any moving mechanical parts.

This valve measures and pours directly into a paper cup by gravity from one of two standard 40-qt milk cans in the milk vendor. When the cans are empty, the valves are thrown away. Being inert and completely nontoxic and, therefore, universally approved and accepted for use with milk and foods, polyethylene plastic was selected for the valve and plunger.



MOLDED NYLON CABLE HANGERS Nyloclips, a line of preformed, molded Nylon cable hangers, are being marketed by the Burndy Engineering Co. Lightweight, flexible, and with smooth, rounded-edge, nonabrasive surfaces, these nylon cable hangers have a high tensile strength and are unaffected by oils, gasoline, alcohol or hydraulic fluids (including noninflammable types). Resistant to sustained temperatures from —60 to 250 F, the clips retain their original shape permanently, and require no shaping or forming on the job. An insulator itself, this material hanger cannot cause ground or short circuits, and is free from hysteresis losses.



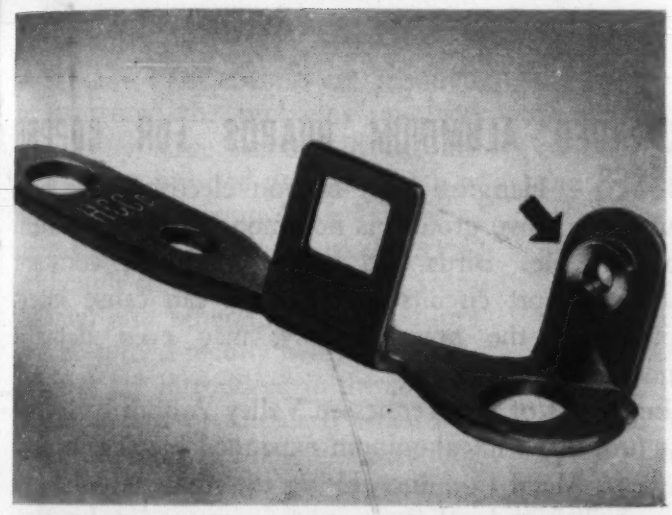
TRANSFORMER TAP SUPPORT Fabricated of a fibrous material, a tap changer support used by Westinghouse in a transformer will not blister when immersed in hot transformer oil. This material, Duroid 700, maintains its mechanical strength in oil at 90 C. Danger of weak spots in the insulating barrier is eliminated. Another feature of the material is that it can be formed into thin-sectioned high strength ribs and marked so that numbers can be seen through the oil. Supplied by Rogers Corp. the nonbrittle, rigid material is listed by Underwriters' Laboratories for the sole support of current-carrying parts.

PLASTICS LIGHT HOUSING

A rugged plastics housing resistant to sea-water corrosion is notable on a battery-powered ship's lantern which Bassons Industries Corp. is producing for the U. S. Navy's Bureau of Ships. Made of Royalite styrene copolymer sheeting, the plastics housing is superior to the cast iron housing it replaces in that it weighs 4 lb less and has good dielectric properties which obviate the hazzard of electrical shock.

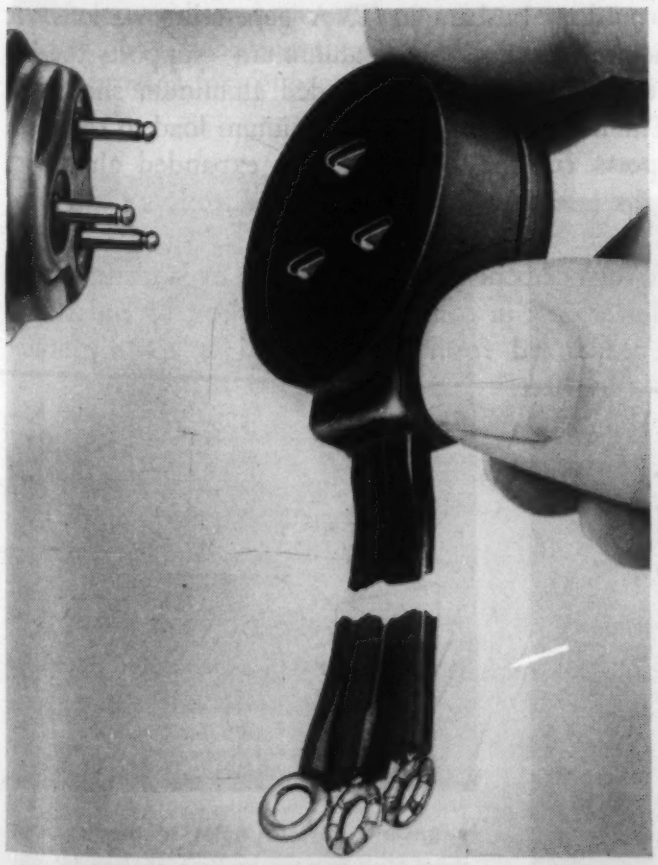
The new housing led to a radical redesign of the lantern, which made it leakproof. For example, it now has a cemented seal between the housing and the Plexiglas window in place of of the earlier screw fastenings, thus protecting the inner parts against seepage and consequent corrosion.

The top and bottom caps of the lantern are also made from Royalite, as is the frame which holds the batteries. This frame is fitted with clips of the same plastic which hold all sizes of batteries in place because of the resiliency of the material. In the original metal frame, some types of batteries wobbled because they did not fit exactly. Royalite is furnished by the United States Rubber Co.



VENTILATED TUNGSTEN CONTACTS

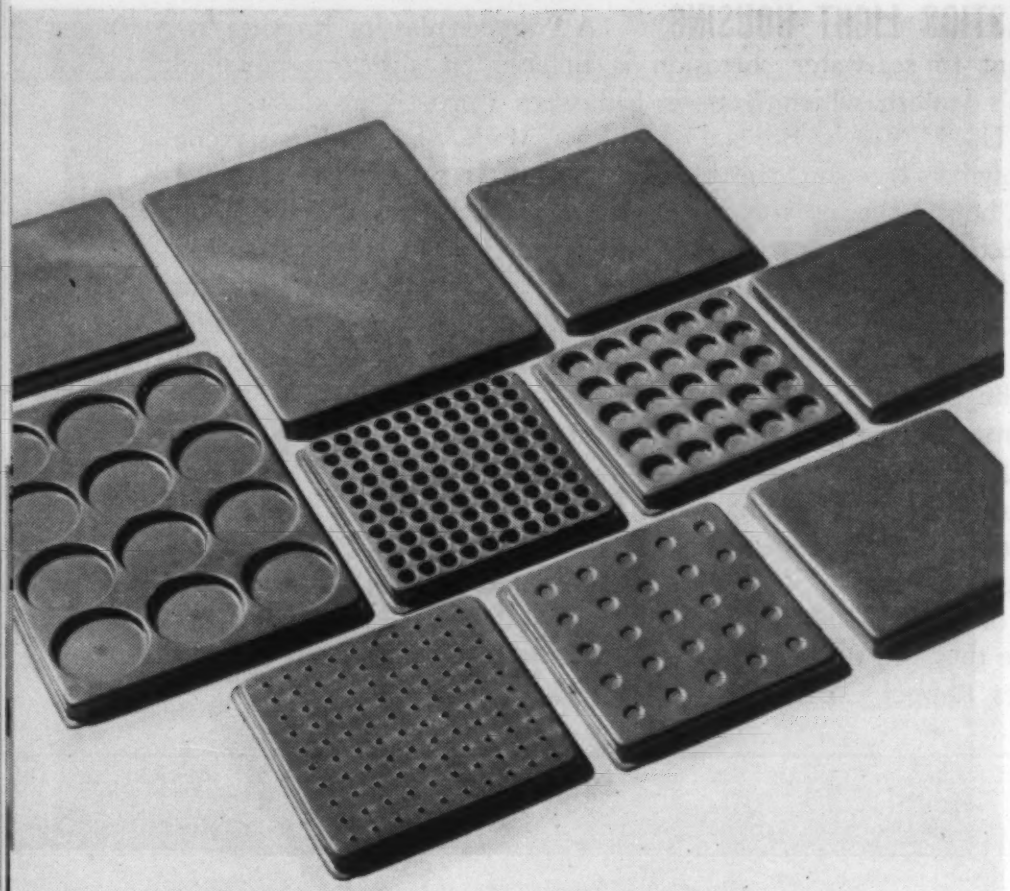
An ignition problem has been reduced by a new type of tungsten contact developed jointly by Holley Carburetor Co. and Fansteel Metallurgical Corp. The problem is the tendency of the tungsten contacts to transfer metal from one point to the other. The cause is the arc, which occurs between the tungsten contacts as they operate. It has been known that if one of the contact points is ventilated, the transfer effect is greatly diminished. Ordinarily, the production of a metal disk with a ventilating hole presents no difficulties. Tungsten, however, is a hard, dense, refractory metal, and the matter of providing a ventilated tungsten disk in mass production quantities presented some metallurgical problems of major proportions. The problems were overcome, and Fansteel is now producing ventilated tungsten contacts in commercial quantities. Laboratory tests, verified by road tests, indicate that ventilated contacts are giving approximately three times the life of conventional contacts, with better engine performance.



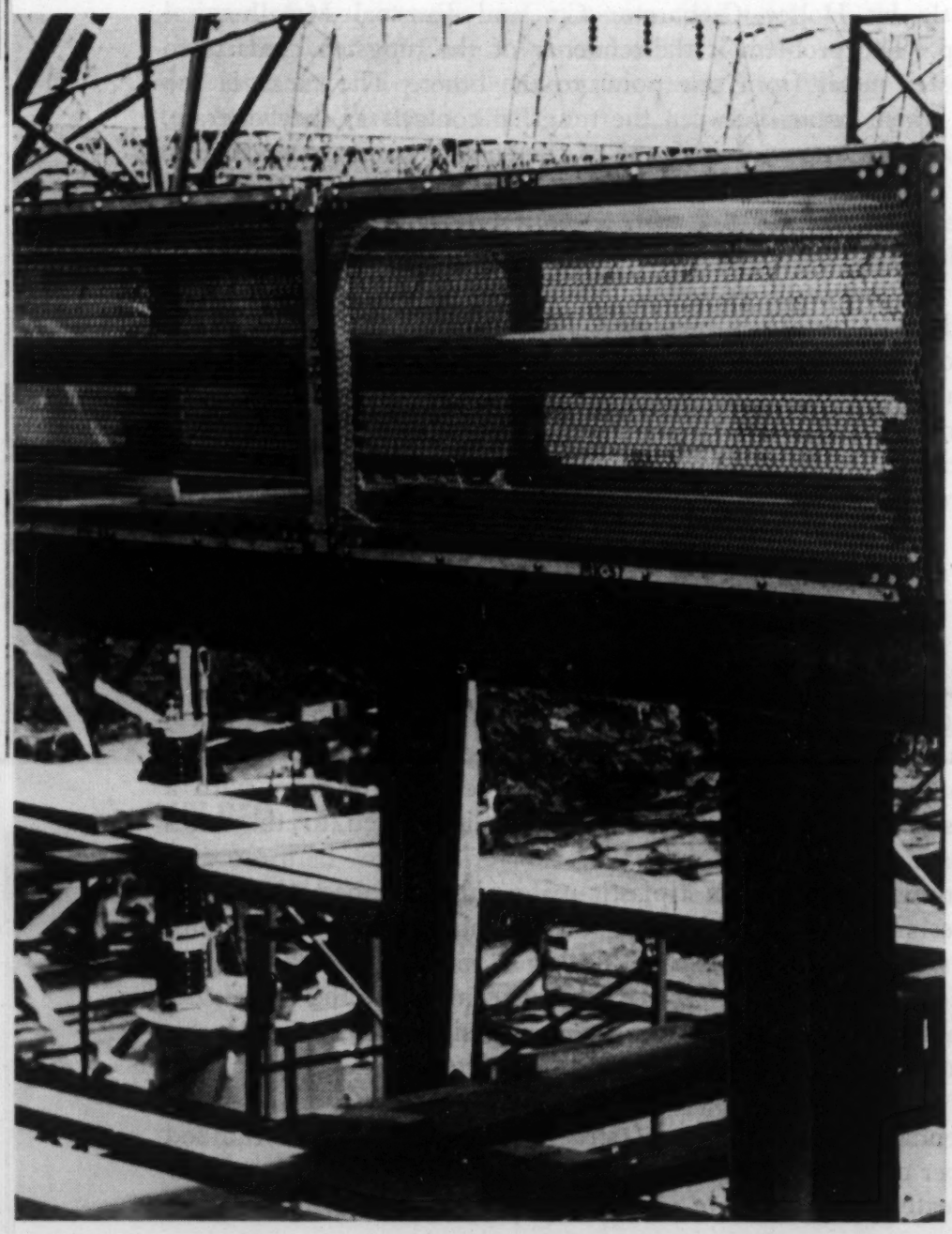
MOLDED RUBBER CONNECTOR

A three-prong connector designed and produced by Riverside Manufacturing and Electrical Supply Co. is solving several problems for refrigerator manufacturers. The part connects the refrigerator relay with a glass-to-steel hermetic terminal, which is welded to the compressor.

Formerly made from a plastic material, the connector case was re-designed to be molded in rubber. This design change eliminates possibility of damage during storage or handling, and speeds assembly as well, since workers can handle the connectors with less care. The contacts were re-designed to permit faster assembly. Since the contacts are completely encased in rubber they cannot spring apart, and the electrical connection is more dependable. The additional structural strength of the molded rubber case and isolation of the three contacts give the connector a greater pull-out rating.



PLASTIC PARTS TRAYS Rejections on fragile precision parts can be reduced by trays fabricated from Boltaron, a high-impact, low-pressure formable plastic sheet material, produced by Bolta, Lawrence, Mass. Having good resistance to impact and abrasion, trays of Boltaron are tough, lightweight and soft to delicate parts. They are chip-proof, acid-proof and oil resistant. There is no problem with corrosion and no difficulty in cleaning due to retention of residual oils and greases. Color coding for individual departments is an easy matter, since the Boltaron material is available in a large variety of standard colors. Taking inventory of the day's production can also be simplified by the multiple-cavity design. Each section holds a definite number of parts and, at a glance, these parts can be counted by merely checking to see whether the trays are full. The trays are also designed with interlocking construction for easy stacking. One company uses the bottoms only for inter-department handling, so that each tray is placed on the preceding tray, forming a cover.



EXPANDED ALUMINUM GUARDS FOR COPPER BUSSES Hanging high tension electrical bus bars many feet above ground is not enough to isolate them from trouble. Birds and flying debris are constant hazards. Short circuits of this type can cause interruptions in the power supply, may even damage generating equipment.

Engineers of the Tennessee Valley Authority solved this problem with aluminum expanded metal supplied by Penn Metal Co., Inc. Using this material, the engineers designed a light-weight, noncorrosive housing for outdoor busbars in TVA generating stations. A structural frame—also of aluminum—supports the ½- by 0.081-in. standard expanded aluminum sheets.

The new housings add a minimum load to the main supports for the bus bars. The expanded aluminum weighs less than the solid sheet and offers little wind resistance.

A further benefit claimed for the expanded metal is its lower cost in comparison with sheet of equal area. The expanded form of the metal is actually stiffer than the sheet.

Brazing Vacuum-Tight Joints in High Nickel Alloys

Here is how Sylvania made several consecutive brazes on relatively large parts to produce a clean, oxide-free, vacuum tight assembly.

by ROBERT A. WALLACE and WILLIAM R. VANDERVEER,
Central Engineering Labs., Sylvania Electric Products, Inc.

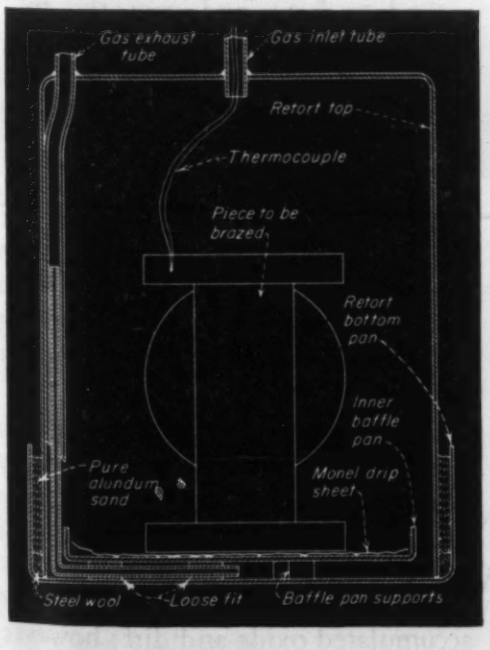
● SPECIAL PROCEDURES are required to overcome the problems involved in brazing large sections of Inconel to obtain a finished product which is clean and free from oxides and vacuum tight to a helium leak detector. Although small parts produced from Inconel and other high nickel alloys can be joined readily by brazing, difficulties are introduced in the joining of larger parts, particularly when several consecutive brazing operations are required. The elements chromium, aluminum, titanium and the like form oxides which are very refractory, and the atmosphere of the usual furnaces for copper alloy brazing will not reduce or "clean-up" these oxides. Inconel, specifically, contains from 14 to 17% chromium, and this necessitates the use of an extremely dry and oxygen-free hydrogen atmosphere.

Every brazing operation is essentially a method of bringing the piece to be brazed to a given temperature in a controlled amount of time in the presence of a specific atmosphere. Where large pieces are involved for which the usual equipment is not adequate and where specialized equipment is not available, various difficulties are encountered. One way to solve this problem follows.

Part and Brazing Equipment

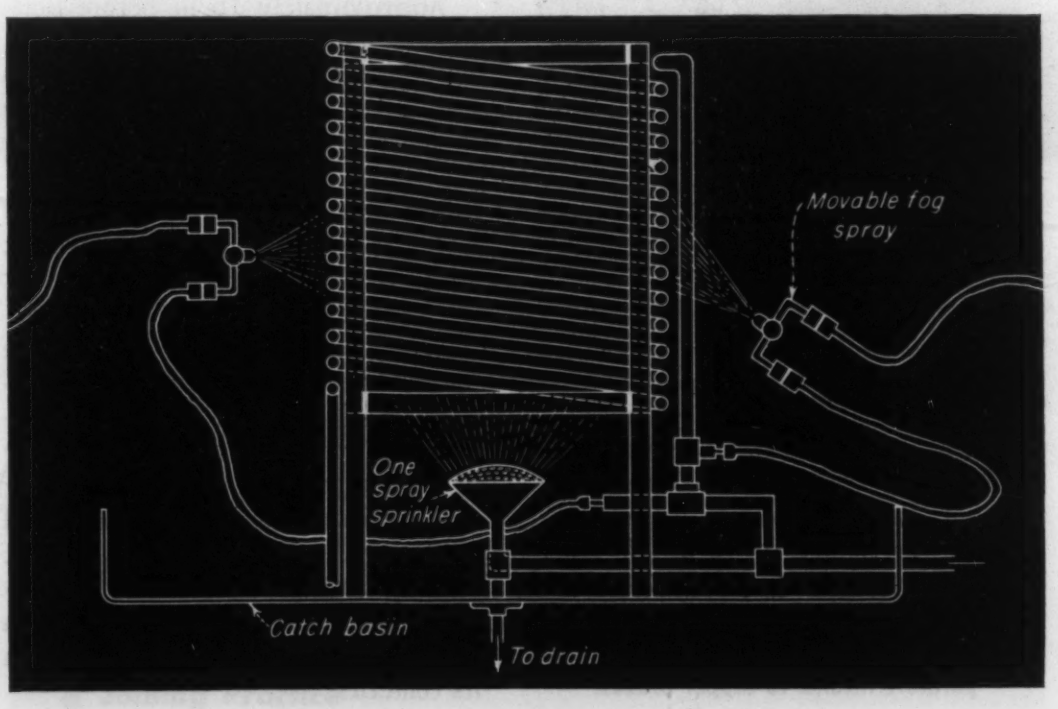
The brazing job was the fabrication of the main tube for a sensitive mass spectrometer. Accordingly, because of the very nature and purpose of this instrument, several exacting requirements had to be fulfilled. One of the first of these was the use of nonmagnetic material. Inconel was chosen for the more critical regions, and type 304 stainless steel made up the rest of the tube, except for the analyzer section, which was to be gold plated copper. Both of the "white" metals had suitable corrosion resisting characteristics, and the gold plate protected the copper. The tube, designed as a demountable sectionalized unit, is assembled with bolted flanges of such design that all of the flange-to-tube joints had to be vacuum tight. Cleanliness of all the internal surfaces after brazing was also of prime importance.

The brazing equipment consisted of a retort large enough to hold each of the pieces to be brazed along with its "jigging" structures, and a furnace large enough to hold the retort and capable of reaching 2370 F with the full thermal load. The accompanying drawing shows the design of the retort including the internal baffle pan, telescoping exhaust tube and the method used to get a tight, but easily opened seal. The open top "pit" structure allowed loading and unloading vertically, using a hoist and sling for the retort. Sliding refractory furnace covers were notched to pass the sling bars and hydrogen inlet and exhaust tubes. Heat leaks around the cover seams were bricked



Arrangement of retort for the brazing of Inconel parts to produce vacuum-tight joints.

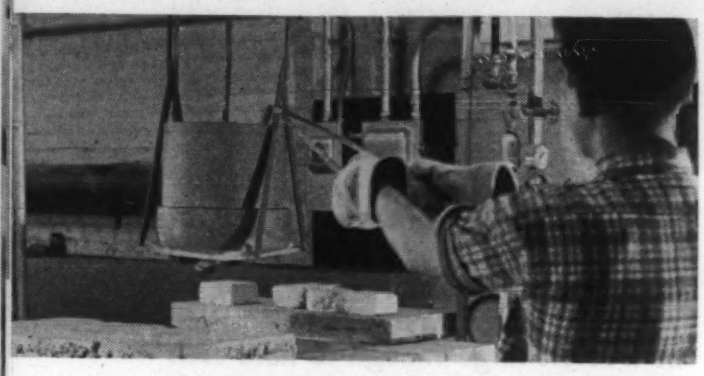
Arrangement for the rapid cooling of the retort to prevent oxide film formation.



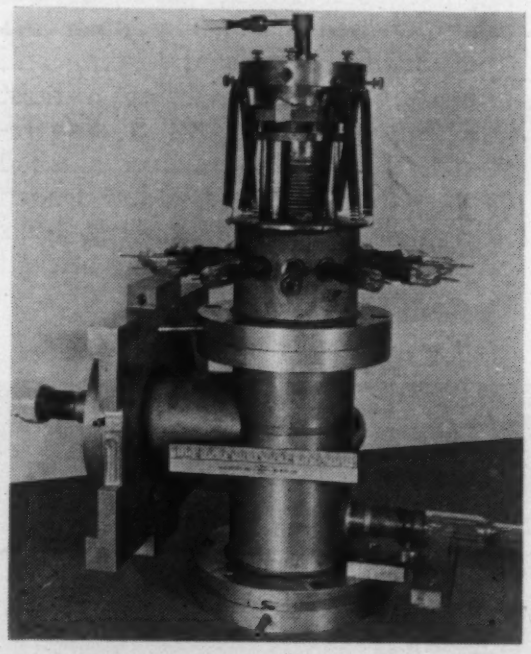
over with loose furnace brick.

As far as the piece to be brazed was concerned, the parts were of standard design. Tolerances allowed a 0.002-in. clearance. The filler material was certified OFHC copper, which is used throughout the vacuum tube industry.

Since a slightly rough or etched surface presents better capillary crevices for the flow of the filler, no polished surfaces were used—especially in the joints. Most surfaces were about 60 micro-inches rms. Copper brazing filler will not flow as far on Inconel or stainless steels as on the non-nickel-bearing types because the molten copper will rapidly pick up enough nickel from the steel to reduce is fluidity. This property works to great advantage in controlling the fillets. In fact, a new joint can be made without losing control of the joints already made merely by rebrazing the piece, and advantage was taken of this fact.



Removing hot retort from furnace. Dry hydrogen atmosphere in the retort removes oxide from the surface of the Inconel and protects it during the brazing operation. The Alundum sand seal makes a tight but demountable joint allowing quick loading and unloading.



Brazed assembly of Inconel units. Flange to tube joint and all other brazes in the upper unit were brazed in one operation. A second operation brazed all electrode support tube seals shown protruding from the area directly below the bellows unit without losing control of the previous brazes. The brazes shown on the lower main tube section were completed in one operation with the exception of those leading to the glass seals. These are low temperature Inconel-to-copper brazes.

The first precaution taken in preparing the work for brazing was to see that no sulfur- or lead-bearing lubricating oils were used in machining the parts; otherwise serious embrittlement occurs which cannot be corrected. Traces of these two contaminents must also be kept out of the retort and holding fixtures.

Cleaning after machining consisted of chemical pickling to remove oxides and scale, preceded where necessary by sandblasting or other mechanical means. Final steps were washing in hot detergent solution, vapor degreasing, and rinsing in chemically pure acetone or methanol. The parts were then wrapped in special sulfur-free paper to await firing. If they were to be held more than three days, they were placed in a dehydrator.

Oil-pumped hydrogen, dried by passage through an extensive drying system, to a dew point below —85 F was used as the atmosphere in the retort, after it was determined that a dew point of —58 F was not satisfactory. With an ample source of sufficiently dry hydrogen, a firing schedule was set up which allowed the firing of one retort load each 24 hr.

Brazing Schedule

Approximately 18 hr before brazing the retort was loaded and sealed. It was then purged of air by allowing nitrogen to pass through the drying train. After a preliminary test for large leaks, hydrogen was admitted at a flow rate of 15 cu ft per hr to the drying train and refrigerant added to the cold traps. A final test for leaks was performed.

When it was ascertained that the retort was properly loaded, assembled and sealed, the hydrogen pressure was reduced to maintain a flow of approximately 5 cu ft per hr.

The furnace was set to 1830 F and held until temperature was stable. The hydrogen flowed for about 15 hr to remove absorbed water from the lines, from the retort, and from its contents.

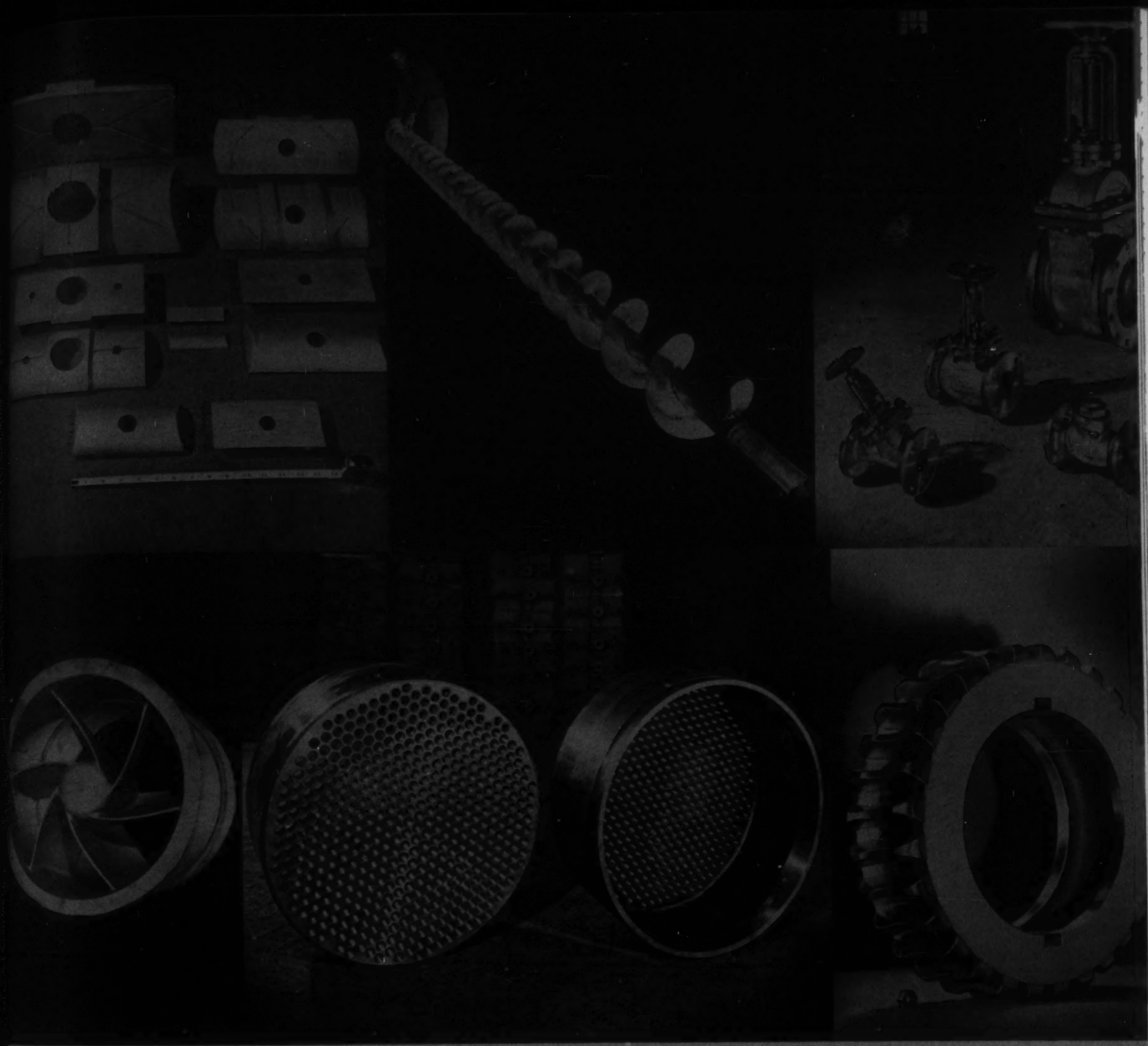
Following these preliminaries the furnace temperature was raised to 2280 F, all cold traps were refilled, and the hydrogen flow was increased to 15 to 20 ft per hr.

When the furnace reached temperature, the retort was placed into the fire pit, and the covers replaced and sealed with loose fire brick. All this was done as rapidly as possible to minimize cooling of the furnace. The furnace temperature was reduced to 2065 F and a series of temperature measurements was started using an optical pyrometer. When the retort temperature reached 2050 F, retort and sling were quickly transferred to a cooling station, where it was brought down to room temperature as rapidly as possible by cold water fog sprays, a water fountain and the effect of the radiant cooling of the surrounding copper coil. Accompanying figure gives the details of this unit. The fog nozzles were directed by hand to various parts of the retort, covering it as evenly as possible. Care was taken to prevent soaking the sand seal and cooling was continued until all parts of the retort were cool enough to allow the bare hand to remain in contact with them.

This quenching of the retort may seem an unconventional, and dangerous operation, and admittedly it is hard on the retort. However, if it was allowed to cool either in the furnace or in room air, the resulting pieces were not quite clean. A haze ranging from light grey to blue would show on the surface of the Inconel. It is thought that when rapidly cooled the piece does not remain in the oxidizing range long enough to be contaminated. The time required to heat and cool the piece seems especially important when low temperature brazing alloys are used; generally, it can be said, the quicker the better.

This completes the firing schedule, save for the operations involving the final clearing of the hydrogen from the retort and lines with a nitrogen flush, opening the retort, removing the brazed piece, and cleaning up for the next load.

An accompanying photograph shows the brazed unit. This assembly has been pumped down to vacuums greater than the 1×10^{-6} mm of Mercury. It has been in use for months, and the outside shows the accumulated oxide and dirt; however, the inside surfaces are bright, clean and uncontaminated.



Aluminum Bronze

by John L. Everhart, Associate Editor, Materials & Methods

MATERIALS & METHODS MANUAL No. 89

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

DECEMBER 1952

The aluminum bronzes have a wide range of mechanical properties which combined with resistance to abrasion and corrosion have led to their application to machine parts and in the process industries. To assist the engineer in the selection and application of these materials, this manual discusses the following points:

- ***Classification***
- ***Engineering Properties***
- ***Processing and Fabrication***
- ***Joining Practice***
- ***Heat Treatment***
- ***Surface Finishing***
- ***Applications***

Introduction

Alloys of copper containing up to about 15% aluminum are called aluminum bronze. These alloys have been known for many years, but, until recently, their fields of application have been rather restricted. Increasing familiarity with their properties and possibilities is widening this range considerably and leading to their greater use in industry.

Aluminum bronzes are a versatile group of alloys. By a suitable choice of composition, the mechanical properties can be varied from those of moderately strong alloys with excellent ductility to high strength alloys which still retain fair ductility. In mechanical properties, some of the aluminum bronzes compare favorably with the mild steels. The resemblance is further enhanced by the fact that some of them can be heat treated by procedures similar to those used for the steels. Aluminum bronzes have good resistance to corrosion and are resistant to scaling at elevated temperatures, two factors which are leading to their increasing use in the process industries. Their resistance to wear and low coefficients of friction in contact with other metals are responsible for many uses in machine parts and in the overlaying of ferrous metals for improved wear resistance.

For many years, the major application of aluminum bronzes was in castings for mechanical service. However, several developments have led to their wider acceptance in recent years. Among these factors were improvements in casting methods, development of joining procedures, and the shortage of tin and nickel.

The search for unusual combinations of properties, which continues unceasingly in the engineering field, has also resulted in increasing the field of application of these materials. The nonmagnetic properties of the aluminum bronzes, coupled with their good strength and corrosion resistance, have led to their use in certain marine applications, while the vibration damping properties, together with specific gravities lower than those of other copper alloys, have opened applications in the field of aviation.

This Manual outlines the properties, fabrication and applications of the aluminum bronzes, with the objective of assisting the materials engineer in determining where these alloys can be profitably employed in solving his problems.

Classification

Although aluminum bronzes are produced containing up to 15% aluminum, most of the important commercial alloys contain from 4 to 11% aluminum with or without additions of iron, nickel, manganese, silicon or other elements. There are many proprietary alloys, some containing more and some less than this aluminum content, but a relatively small group covers the major tonnage in use in this country, and this Manual has been limited to these alloys.

For the purpose of reporting the properties of the alloys, the nomenclature, followed in this Manual, is based on that used in the "Rod Handbook," published by the Copper and Brass Research Assn., and on the standard alloys of the Brass and Bronze Ingot Institute. The alloys designated 5, 7, 8, 9 and 10% aluminum bronze and aluminum silicon bronze follow the CABRA system. Those marked 9A, 9B, 9C and 9D are BBII alloys. All of these alloys are covered by ASTM specifications. The alloys included in the CABRA list are those used most commonly as wrought materials, those on the BBII list those used most commonly as castings. However, neither group is limited in this fashion, since some of the former alloys are used in the cast form while the latter are used also for forgings and extruded products. It must be emphasized that the listing is purely arbitrary.

Although such a classification is useful in reporting properties of the commercial materials, it is not suitable for discussing the fabricating characteristics of the aluminum bronzes, for these depend on the metallurgical structure.

Structurally, there are two types of aluminum bronze: (1) single-phase alloys, and (2) two-phase alloys, which are often called "duplex" aluminum bronzes. Although 9.8% of aluminum is soluble in copper, and under equilibrium conditions alloys containing this quantity of aluminum would have a single-phase structure, in commercial practice equilibrium is seldom achieved. Under such conditions, alloys containing more than about 8.4% aluminum usually contain a second phase. Thus, commercially, the dividing line between single-phase and duplex alloys occurs at approximately 8.4% aluminum.

Characteristics of the two types of alloys differ greatly. The single-phase alloys resemble the other single-phase copper alloys in their general characteristics. They can be readily cold and hot worked and can be strengthened only by cold-working. These alloys are not hardenable by heat treatment. The duplex bronzes, on the other hand, can be cold worked only to a limited extent, but can be readily hot worked. In their response to heat treatment they resemble the steels more nearly than the other copper alloys, for they can be hardened and tempered. In discussing the fabrication of the materials, it is necessary to consider them as two separate and distinct groups and to deviate from the commercial classification, for there is no sharp line of demarcation between the commercial alloys. The properties and characteristics of these materials change gradually from the purely single-phase alloys through a transitional group to the duplex alloys.

Engineering Properties

The original aluminum bronzes contained only copper and aluminum, but the modern commercial alloys usually contain other elements. Iron is generally added in the range 0.5 to 5% to increase the strength and hardness and assist in refining the grain structure. Nickel, added in amounts up to 5%, also increases the strength and refines the grain but its effect is not as great as that of iron. Manganese is added as a scavanger for gases. It also refines the grain and improves the strength of the alloys. Silicon is added as a substitute for aluminum in some modified alloys, particularly to increase the machinability of the alumi-

After rolling on this mill, strip is annealed in the furnace shown in the background and rolled to finished gage. (Revere Copper and Brass, Inc.).

num bronzes. The composition known as aluminum silicon bronze is used because it is quite readily machinable.

Physical Properties

The more useful physical properties of the commercial aluminum bronzes are included in Table 3. The alloys have narrow freezing ranges. Their specific gravities are considerably lower than those of the other common copper-base alloys. Their coefficients of expansion and moduli of elasticity are in the same range as those of copper, while their electrical conductivities are somewhat lower than those of the phosphor bronzes.

Mechanical Properties

The strength and ductility of the binary aluminum bronzes increases progressively with the aluminum

Hub and blades for an adjustable pitch marine propeller produced from aluminum bronze by American Manganese Bronze Co.

Table 1—Nominal Compositions of Aluminum Bronzes
(The designations are arbitrary, as explained in the text)

Designation	Cu	Al	Fe	Ni	Mn	Si
WROUGHT ALLOYS*						
Aluminum Bronze 5%	95	5	—	—	—	—
Aluminum Bronze 7%	90	7	2.5	—	—	—
Aluminum Bronze 8%	92	8	—	—	—	—
Aluminum Bronze 9%	87 min	7–10	1.5 max	**	**	—
Aluminum Bronze 10%	82	9.5	2.5	5	1	—
Aluminum Silicon Bronze	91	7	—	—	—	2
CAST ALLOYS***						
Aluminum Bronze 9A	87.5	9	3.5	—	—	—
Aluminum Bronze 9B	89	10	1	—	—	—
Aluminum Bronze 9C	83 min	10–11.5	3–5	2.5 max	0.5 max	—
Aluminum Bronze 9D	81	11	4	4	—	—

* *Some of these alloys are also used in cast form.*
** *Ni + Mn + Sn 2% max.*
*** *These compositions are also used in wrought form, particularly for forgings and extrusions.*

Table 2—Some Approximately Applicable Commercial Specifications
(The original specifications should be consulted for details)

Designation	ASTM	SAE	AMS
WROUGHT ALLOYS			
Aluminum Bronze 5%	B169, alloy A	701 A	—
	B124, alloy 10	—	—
	B111	—	—
Aluminum Bronze 7%	B169, alloy D	701 B	—
Aluminum Bronze 8%	B169, alloy C	—	—
	B124, alloy II	—	—
	B150, type I	—	—
Aluminum Bronze 9%	B150, type I	701 B	4630 A
	B124, alloy II	—	4632
Aluminum Bronze 10%	B150, Type 2	—	—
	B171	—	—
Aluminum Silicon Bronze	B124, alloy II	701 B	4631 A
CAST ALLOYS			
Aluminum Bronze 9A	B30, alloy 9A	68, Grade A	—
	B148, alloy 9A	—	—
Aluminum Bronze 9B	B30, alloy 9B	68, Grade B	—
	B148, alloy 9B	—	—
Aluminum Bronze 9C	B30, alloy 9C	—	4870 A
	B148, alloy 9C	—	4871 A
			4872
			4873
Aluminum Bronze 9D	B30, alloy 9D	—	—
	B148, alloy 9D	—	—

content up to about 8.4% aluminum. The appearance of a second phase with increasing aluminum content above this quantity is accompanied by an abrupt increase in strength and a corresponding decrease in ductility. The alloys containing more than 8.4% aluminum become progressively more brittle, and those containing more than 14% are used in a rather limited range of applications.

The single-phase alloys are used mainly in the wrought form. Typical properties of the commercial alloys are given in Table 4. Like other single-phase copper alloys, the aluminum bronzes are hardenable by cold work. The effects of cold working on strength and ductility are indicated.

The duplex alloys are used in cast and hot-worked forms, for they can be cold-worked only to a limited extent. Some properties of the commercial grades are included also in Table 4. The duplex alloys are hardenable by heat treatment, a process which will be discussed in a later section of the Manual.

Among properties which do not appear in the table is the excellent wear resistance of the aluminum bronzes, a property which is the basis of a number of applications.

Elevated Temperature Properties

Because of the formation of a thin adherent oxide skin on the surface, aluminum bronzes are among the most resistant to scaling and oxidation at elevated temperatures of the copper alloys. The information which has been published on the short-time elevated temperature properties of the aluminum bronzes indicates that they retain most of their strength up to 300 to 400 F. Beyond 600 to 750 F the decrease in strength is rapid. Shock resistance, as indicated by impact test, follows the same trend.

Long-time elevated temperature properties have been reported for a number of the aluminum bronzes. Creep data determined by Voce on three duplex alloys are included in Table 5. The structural changes occurring in the duplex alloys will be mentioned under heat treatments, and it is sufficient to note that he found stabilized structures superior in creep resistance to unstabilized structures. Further, the addition of iron or of iron and nickel considerably improved resistance of aluminum bronzes to creep. Creep data on a number of other alloys are included in Table 6.

Low Temperature Properties

In common with other single-phase copper alloys, aluminum bronzes containing less than 8.4% aluminum retain their ductility at low temperatures. There is some increase in strength and hardness with falling temperatures and moderate stiffening, as indicated by the increase in modulus of elasticity. These alloys should be satisfactory for service at least to —295 F.

Some of the duplex alloys behave similarly. Others, at the higher range of aluminum content, show a greater drop in ductility with falling

temperatures. They are less suitable for low temperature service than the single-phase alloys or duplex alloys of lower aluminum content.

Fatigue and Corrosion Fatigue

Fatigue data are scattered and little information is available on the relationship between fatigue strength and structure of the alloys. However, heat treated material seems to be superior in fatigue strength to slowly cooled material.

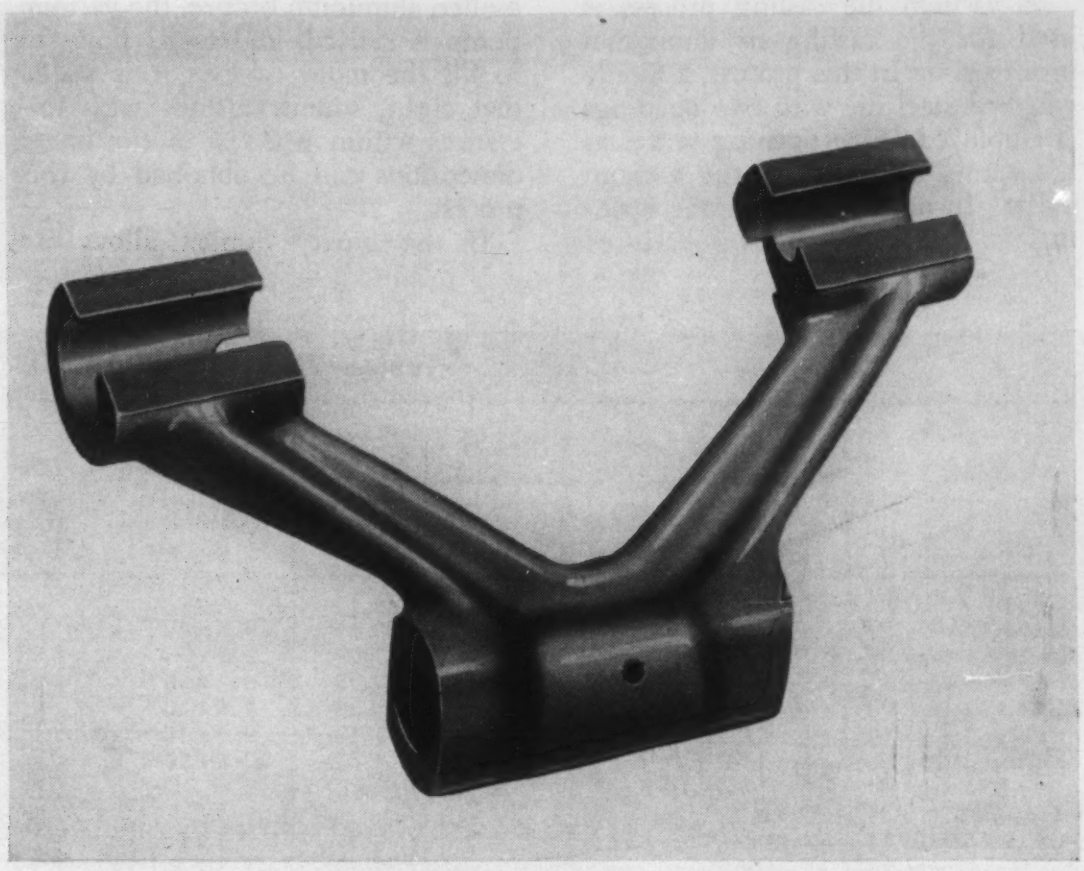
Gough and Sopwith have reported data on the corrosion fatigue of two aluminum bronzes. The results indicate that there is a reduction in fatigue strength of aluminum bronzes under corrosive conditions, but they are less affected than most copper alloys. Aluminum bronzes are superior to carbon steels in resistance to fatigue under corrosive conditions.

Corrosion Resistance

In general, aluminum bronzes have corrosion resisting characteristics similar to those of phosphor bronzes. Although formation of a surface oxide film is often given credit for improving the corrosion resistance of aluminum bronzes, this effect is limited to specific environments. For example, as mentioned previously, the film improves the resistance to scaling at elevated temperatures. In many solutions, however, the resistance of these alloys is similar to that of copper, and the basis for selection of aluminum bronzes is frequently their combination of high strength with good corrosion resistance.

Effects of composition and structure have not been fully evaluated. Within the range of compositions used commercially, corrosion resistance does not appear to increase with aluminum content. Presence of a second phase in the duplex alloys does not necessarily reduce corrosion resistance, but such alloys are susceptible to de-aluminization in some solutions. Effects of alloying elements, particularly iron, nickel and manganese in the quantities in which they are present in the usual commercial alloys, are the subject of considerable controversy. In some cases, increased corrosion resistance has been attributed to the presence of these elements. On the other hand, it has been stated that binary copper aluminum bronzes have greater resistance to sea water corrosion than those containing iron.

Table 8 gives an estimate of resistance of aluminum bronzes to attack by a number of corroding media. This table should be used only as a preliminary guide to the suitability of the materials for use in a particular environment. Rates of corrosion are affected so greatly by purity of solution, aeration, flow of the liquid, temperature and other factors that no specific recommendations are possible and an actual test is desirable.



Roller yoke bracket used in a variable speed transmission produced from aluminum bronze 9B by vacuum die casting. This yoke replaced a sand casting of ordinary bronze with a weight saving of 20% and required only reaming for finishing. (Aurora Metal Co.)

Processing and Fabricating Properties

Casting

Because of their narrow freezing range and high shrinkage, aluminum bronzes are difficult to cast satisfactorily. In addition, these alloys are quite gas sensitive, and melting practices must be adopted which will minimize gas absorption. For many years these factors limited the applications of aluminum bronzes.

However, procedures have been developed which permit production of satisfactory castings and contribute to wider use of aluminum bronzes in this form. A complete discussion of casting methods is beyond the scope of this Manual. It is sufficient to mention that in melting, precautions are taken to minimize stirring and breaking the oxide skin on the surface of the melt to prevent absorption of gases. In pouring, agitation is avoided and castings are generally bottom-gated to reduce turbulence. Shrinkage difficulties are overcome by use of large risers to feed the casting and chills to prevent directional solidification. With proper attention to such details, satisfactory sand castings have been produced which have been used even in applications requiring pressure tightness. All of the alloys can be sand or centrifugally cast, while some of the duplex alloys can also be die cast.

A vacuum die casting process is used for the casting of aluminum bronze also. In this process, a totally enclosed steel die with two openings is employed. One opening serves as the sprue, the other as the vacuum outlet. In operation, the sprue opening is submerged into a bath of molten aluminum bronze, the vacuum pump is started, and metal flows in to fill the mold cavity. It is stated that clean, sound castings with tolerances within ±0.5% of the linear dimensions can be obtained by this process.

If the binary duplex alloys are slowly cooled, they may develop a brittle structure because of the formation of eutectoid, the extent of such formation, depending on rate of cooling and aluminum content. On extremely slow cooling, these alloys may develop a course grain structure accompanied by a reduction in

Table 3—Typical Physical Properties

Designation*	Melting Range		Density	Sp Grav	Coeff of Ther Exp per F	Ther Cond Btu/Sq Ft/ Ft/Hr/F at 68 F	Elec Cond % IACS at 68 F	Sp Heat Btu/Lb at 68 F	Mod of Elast (Ten) Psi
	Liquidus, F	Solidus, F	Lb/Cu in. at 68 F						
WROUGHT ALLOYS									
Aluminum Bronze 5%	1940	1920	0.295	8.17	9.9×10^{-6} (a)	43	17.5	—	17,000,000
Aluminum Bronze 7%	—	—	0.279	7.73	9.0×10^{-6}	—	12.8	—	18,000,000
Aluminum Bronze 8%	1904	—	0.281	7.78	9.9×10^{-6} (a)	41	14.8	—	19,000,000
Aluminum Bronze 9%	1905	1890	0.274	7.58	9.4×10^{-6} (a)	35	12.6	0.104	—
Aluminum Bronze 10%	1930	1895	0.274	7.58	9.4×10^{-6} (a)	22	7.5	0.104	—
Aluminum Silicon Bronze	1810	—	0.278	7.69	10.2×10^{-6} (a)	26	9.2	—	16,000,000
CAST ALLOYS									
Aluminum Bronze 9A	—	—	0.267	7.4	9.5×10^{-6} (b)	—	13	—	17,000,000
Aluminum Bronze 9B	1900	—	0.270	7.47	9.5×10^{-6} (c)	33	13.5	—	15,000,000
Aluminum Bronze 9C	1910	1850	0.272	7.52	9.0×10^{-6} (c)	—	12	—	18,000,000
Aluminum Bronze 9D	1937	—	0.273	7.55	—	22	7.5	—	17,000,000

* *See Table 1.*
(a) 68 to 572 F.
(b) 70 to 250 F.
(c) 70 to 500 F.

Table 4—Typical Mechanical Properties

Designation*	Form and Condition	Yld Str 0.5% Extension Psi	Ten Str, Psi	Elong % (2 in.)	Hardness	
					Rockwell	Brinell
WROUGHT ALLOYS						
Aluminum Bronze 5%	Sheet, soft	22,000	55,000	65	—	—
	hard	65,000	92,000	7	—	—
	Rod, soft	22,000	55,000	65	—	—
	Tube, soft	22,000	60,000	60	—	—
Aluminum Bronze 7%	Sheet, hard	33,000 min	72,000 min	32 min	B81	—
	Rod, extruded	35,000	75,000	30	—	126
Aluminum Bronze 8%	Sheet, soft	25,000	65,000	60	—	—
	hard	65,000	105,000	7	—	—
	Rod, soft	25,000	65,000	65	—	—
	hard	50,000	80,000	30	—	—
Aluminum Bronze 9%	Rod, soft	40,000	80,000	22	—	—
	hard	55,000	95,000	16	—	—
Aluminum Bronze 10%	Plate, soft	—	90,000	12	—	—
	Rod, hard	60,000	105,000	12	B105	—
Aluminum Silicon Bronze	Rod, soft	50,000	90,000	30	B85	—
	Hot forged	45,000	90,000	30	B85	—
Aluminum Bronze 9A	Rod, extruded	39,000	82,500	22.5	—	160
Aluminum Bronze 9B	Rod, extruded	40,000	80,000	20	—	134
Aluminum Bronze 9C	Rod, extruded	45,000	95,000	12	—	174
Aluminum Bronze 9D	Forging	55,000	105,000	14	—	250
CAST ALLOYS						
Aluminum Bronze 9A	Sand-cast	27,000	75,000	35	—	120
Aluminum Bronze 9B	Sand-cast	32,000	67,000	15	—	140
	Sand-cast, water quenched from 1625 F, tempered 1125 F, water quenched	40,000	90,000	15	—	180
Aluminum Bronze 9C	Sand-cast	35,000	75,000	18	—	155
	Sand-cast, water quenched from 1625 F, tempered 1000 F, water quenched	52,000	105,000	10	—	230
Aluminum Bronze 9D	Sand-cast	45,000	95,000	7	—	195
	Sand-cast, water quenched from 1625 F, tempered at 1150 F, water quenched	70,000	115,000	5	—	235

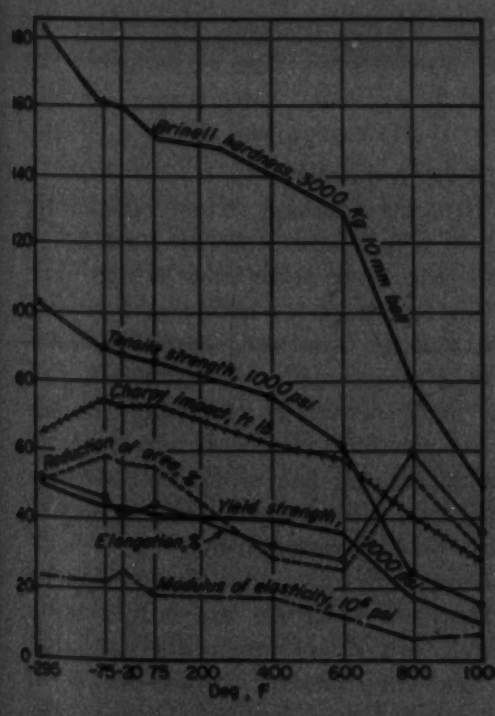
* *See Table 1.*

Vacuum die cast aluminum bronze water pump impeller being removed from the die in the plant of the Aurora Metal Co.

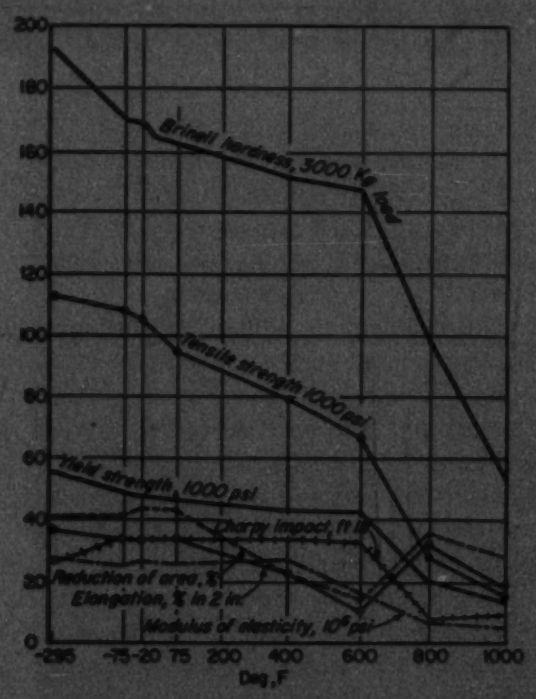
strength. Modifying the composition, particularly by adding iron, improves the properties of the castings, and some authorities state that addition of iron is the cheapest and most effective method of securing a fine grain structure in an aluminum bronze casting.

Most cast alloys used commercially at present contain from 7.5 to 11% aluminum with the addition of such alloying elements as iron, nickel and manganese. These alloys are all duplex materials and can be heat treated. However, improvement in the properties of heat treatment of cast alloys containing considerable quantities of iron and nickel is not great since these alloys develop good properties in the "as cast" condition.

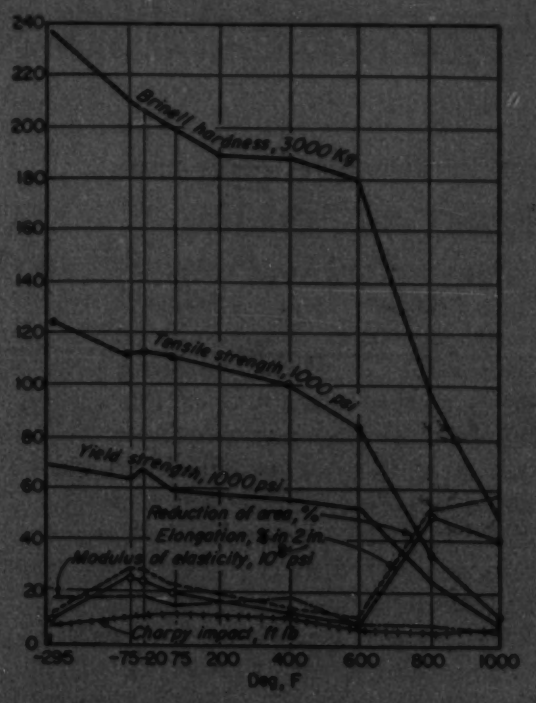
Sand castings ranging from a few ounces to 10,000 lb are in current production, while centrifugal castings have been produced with shipping weights up to 6,000 lb. These figures give an indication of the applicability of the casting procedures for produc-



Effect of temperature on the properties of an aluminum bronze containing 89.62 copper, 7.78 aluminum and 2.57% iron. (Ramsey, Jaffee and Nekervis)



Effect of temperature on the properties of an aluminum bronze containing 9 to 10 aluminum and 2.75 to 3.75% iron. (Ramsey, Jaffee and Nekervis)



Effect of temperature on the properties of an aluminum bronze containing 9.7 to 10.9 aluminum, 2 to 3.5 iron, 4.5 to 5.5 nickel and less than 1.5% manganese. (Ramsey, Jaffee and Nekervis)

Table 5—Effect of Stabilizing on the Creep Properties of Extruded Aluminum Bronze (Voce)

Composition, %	Condition	Temp F	Stress Psi, Corresponding with Creep Rates at the 40th Day of:		
			10^{-5} In./In./Day	10^{-4} In./In./Day	10^{-3} In./In./Day
Cu 89.52 Al 10.47 Fe 0.01	Norm 1 hr at 1515 F, a.c.	480	14,000	23,500	33,000
	Norm and held 4 weeks at 480 F	480	16,300	26,800	37,600
	Norm and stabilized 3 days at 930 F, s.c.	480	19,000	29,800	40,700
	Norm and stabilized 3 days at 930 F, s.c.	750	3,100	6,000	8,700
Cu 87.07 Al 10.13 Fe 2.8	Norm 1 hr at 1515 F, a.c.	480	15,000	27,500	10,700
	Norm and held 4 weeks at 480 F	480	15,700	27,300	41,000
	Norm and stabilized 3 days at 930 F, s.c.	480	21,300	32,500	43,700
	Norm and stabilized 3 days at 930 F, s.c.	750	5,100	8,700	12,300
Cu 80.44 Al 9.86 Fe 4.97 Ni 4.87	As extruded	480	22,000	34,300	46,500
	—	—	—	—	—
	—	750	—	8,300	—
	—	—	—	—	—

NOTES: Norm—normalized.
a.c. —air cooled.
s.c. —slow cooled.

Table 6—Creep Strength of Aluminum Bronzes

Composition, %						Form	Stress, Psi, for 0.01% Extension in 1000 Hr at					Source
Cu	Al	Fe	Si	Ni	Mn		500 F	600 F	700 F	800 F	900 F	
82	9.5	2.5	—	5	1	Extruded and drawn rod	12,000	—	—	—	—	American Brass
82	9.5	2.5	—	5	1	Hot rolled plate	—	12,000	6,000	—	—	American Brass
86.34	9.53	3.50	0.27	—	—	Extruded	—	7,200	4,600	1,600	1,400	Ampco
91.47	7.68	0.66	0.08	—	—	Die cast	9,700	6,100	3,700	2,300	—	Ampco
85.83	11.09	2.77	0.22	—	—	Cast	—	—	3,200	2,800	—	Ampco
85.33	10.85	3.57	0.14	—	—	Cast	—	—	4,400	2,900	1,400	Ampco
85.37	10.06	4.39	0.07	—	0.11	Cast	—	7,400	4,000	2,300	1,200	Ampco
79.70	11.50	4.29	0.05	4.52	—	Cast	—	10,500	5,500	2,400	—	Ampco

tion of aluminum bronze parts.

Forming and Fabricating

Forming and fabrication of aluminum bronzes varies considerably with their structure. Single-phase alloys have rather good cold-working properties at the lower end of the range but become progressively more difficult to cold-work as aluminum content is increased. They are somewhat stiffer than wrought phosphor bronzes, and drawing operations are limited generally to simple shapes. They can also be hot worked readily.

The duplex alloys have poor cold forming properties, and such forming is utilized only to a minor degree. They have excellent hot working properties and are widely used as forging alloys.

Aluminum silicon bronze has poor cold forming properties and is employed as a hot forging alloy and for screw machine products, the latter being the major application.

Cold Forming—The single-phase aluminum bronzes can be formed by bending, deep-drawing and similar operations but are stiffer and less workable than brasses. Generally heavier equipment is required and tooling follows that used for phosphor bronzes or mild steel.

For stamping and perforating, clearance requirements are the same as those for mild steel. Regarding relative workability, one authority states that any part which can be made from mild steel can be duplicated in annealed alpha aluminum bronze, although heavier equipment will be required.

In deep drawing, alloys containing up to 8% aluminum can be worked with the same tools and to the same extent as phosphor bronzes. For such operations, however, ample lubrication is required to prevent scoring of the tools, which is generally attributed to particles of aluminum oxide in the surface of the work and is more severe in aluminum bronzes than in most other copper alloys.

Simple bending operations can be performed cold on all single-phase alloys, but it is frequently desirable to heat the material to 600 or 700 F for more drastic bends. These alloys can also be spun satisfactorily, if the radius of at least 5 to 10 times the sheet thickness is used. Thin sheet can be spun without intermediate

annealing, but material above about ⅛ in. in thickness requires frequent annealing for satisfactory spinning.

Hot Forming — All commercial grades of aluminum bronze can be hot worked, but the duplex alloys probably show somewhat superior properties in this respect.

For forging, the single-phase alloys are generally heated to the range 1500 to 1650 F, and forging is continued until the temperature falls to about 1350 F, or to lower temperatures if the equipment is sufficiently rugged. If forging is continued to temperatures below 1250 F, the part is work hardened. These alloys can also be extruded readily at temperatures of the order of 1500 F, but the extrusion pressures are higher than those required for brasses.

The duplex alloys are forged in the same general temperature range as the single-phase alloys. Presence of iron and nickel in many of the alloys increases the resistance of the metal to flow and, for such alloys, pressure requirements are increased. Duplex alloys can be hot extruded readily in the forging temperature range, and are widely used in the production of extruded shapes.

Machining

Procedures for machining metals have never been standardized and often vary widely from one plant to another. Consequently, there are frequently great differences of opinion on relative machinability. Such differences are apparent in values assigned to the aluminum bronzes, and recommended procedures also differ. The engineer faced with the problem of machining these materials should consult the producers to determine the most suitable methods for use with his equipment. However, some idea of the wide range of recommendations can be given.

The single-phase, alpha, aluminum bronzes are similar in their machining characteristics to the phosphor bronzes. In both types of materials plastic-working occurs and the metal is "upset" before the chip is formed, with the result that long continuous chips are obtained. In the copper alloy field, relative machinability is usually based on free-turning brass rod to which is assigned a machinability rating of 100. On this basis, the alpha aluminum bronzes have been rated by some authorities at 20 to 30, and are classified with those alloys which are difficult to machine. Other experts state that

Table 7—Some Endurance Properties of Aluminum Bronze (Gough and Sopwith)

Composition, %	Condition	Ten Str	Fatigue Limit, Psi		Endurance Ratio		Cycles
			Air	Salt Spray	Air	Salt Spray	
Cu 89.5 Al 8.89 Fe 0.15 Zn 1.40	¾-in. dia rod, extruded and drawn	80,000	32,000	21,600	0.4	0.27	5×10^7
Cu 79.83 Al 9.73 Fe 5.42 Ni 4.97	¾-in. dia rod, forged	116,000	51,000	32,600	0.44	0.28	5×10^7

Table 8—Approximate Corrosion Resistance of Aluminum Bronzes

Good	Fair	Poor
Acetic acid	Aluminum chloride	Acetylene
Aluminum hydroxide	Ammonium sulfate	Ammonia, moist gas
Aluminum sulfate	Barium sulfide	Ammonium hydroxide
Ammonia, dry	Calcium hypochlorite	Ammonium chloride
Atmosphere, industrial, rural, marine	Chlorine, moist	Ammonium nitrate
Barium chloride	Copper nitrate	Chromic acid
Calcium chloride	Ferrous chloride	Ferric chloride
Calcium hydroxide	Ferrous sulfate	Ferric sulfate
Chlorine, dry	Hydrochloric acid	Hydrocyanic acid
Copper sulfate	Hydrofluoric acid	Hydrogen sulfide, moist
Hydrogen sulfide, dry	Phosphuric acid	Nitric acid
Magnesium chloride	Potassium hydroxide	Potassium cyanide
Magnesium hydroxide	Sodium hydroxide	Sodium cyanide
Magnesium sulfate	Sodium sulfide	
Potassium chloride	Sulfuric acid	
Potassium sulfate	Zinc chloride	
Sodium chloride		
Sodium nitrate		
Sodium sulfate		
Sulfur dioxide		
Zinc sulfate		
Water, fresh sea		

Good indicates usable under most conditions.
Fair indicates subject to attack but can be used under certain conditions.
Poor indicates unsuitable.

Table 9—Fabricating Properties

Designation*	Cold Working	Hot Working	Hot Working Temp Range, F	Annealing Temp Range, F
Aluminum Bronze 5%	Good	Good	1500–1600	800–1400
Aluminum Bronze 7%	Poor	Good	—	—
Aluminum Bronze 8%	Good	Excellent	1500–1650	840–1380
Aluminum Bronze 9%	Poor	Excellent	1470–1650	1200–1300
Aluminum Bronze 10%	Fair	Excellent	1470–1740	—
Aluminum Silicon Bronze	Poor	Excellent	1300–1600	—
Aluminum Bronze 9B	Fair	Excellent	1450–1600	—
Aluminum Bronze 9D	Poor	Excellent	1650–1750	—

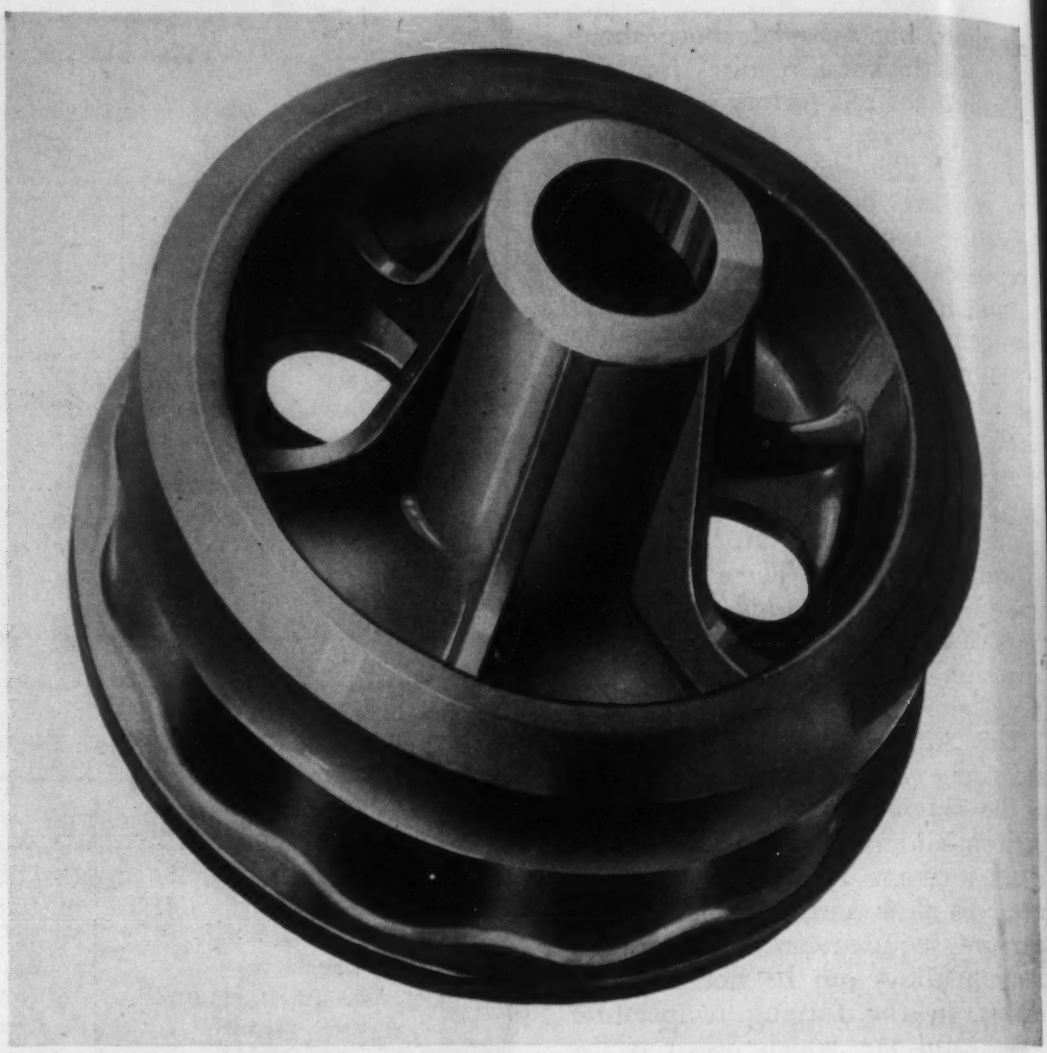
** See Table 1.*

these figures are too low and the alloys should be given ratings of 40 to 50.

The duplex alloys are somewhat more brittle and, although the turnings do not actually break up into small chips, they do shear transversely. This shearing action causes vibration of the tool and increases tool wear unless both tool and work are held rigidly. Although there is this variation in type of chip formed between the single-phase and the duplex alloys, a difference which results in the use of somewhat modified tools in machining the two materials, the duplex alloys are also classified by one group with materials which are difficult to machine and given machinability ratings of 20 to 30, while another group rates them at 50 to 60.

In turning the single-phase alloys, top rake angles of 12 to 15 deg with clearance angles of 5 deg are recommended by some engineers, while others suggest rake angles of 3 deg. For the duplex alloys, a top rake angle of 8 deg is preferred by one group, although this angle may be increased for finishing cuts. Another group suggests 0 deg for the lower duplex and —2 deg for the highly alloyed materials. Parting tools require ample side clearance. Forming tools can be similar to those used for steels, although some authorities believe that greater front clearance is beneficial.

For both types of alloys, one group recommends moderate cutting speeds, the range 100 to 250 sfm being suggested. This group states that higher speed cutting can be employed, particularly for finishing cuts with carbide tools, but tool wear is increased by this practice. Another group states that these speeds are too slow for modern machine shop practice and recommends 800 to 1500 sfm.



Worm gear and clutch housing vacuum die cast from aluminum bronze 9B. Machining operations were reduced considerably by making this part by this procedure rather than by sand casting. (Aurora Metal Co.)

Table 10—Effect of Heat Treatment on the Mechanical Properties of Several Aluminum Bronzes

Nominal Composition	Quenching		Tempering		0.1% Proof Stress, Psi	Ten Str, Psi	Elong, % 2 in.	Vickers DPN (30 Kg Load)	Source
	Temp, F	Time, Hr	Temp, F	Time, Hr					
WROUGHT									
Cu 82.1	1830	½	—	—	26,800	80,500	56	112	Cook, Fentiman and Davis
Al 7.87	1830	½	930	64	50,000	105,000	13	238	
Fe 4.90	1830	½	1290	2	37,200	87,500	23.5	186	
Ni 4.99	—	—	—	—	—	—	—	—	
WROUGHT									
Cu 79.9	1830	½	—	—	57,500	115,000	2	287	Cook, Fentiman and Davis
Al 10.13	1830	½	750	1	114,000	124,000	1	421	
Fe 5.04	1830	½	1110	½	75,800	119,000	7	287	
Ni 4.86	—	—	—	—	—	—	—	—	
CAST									
Cu 8.90	As Cast	—	—	—	32,000	79,000	37	Rockwell B70	Aurora Metal Co.
Al 9.8	1675	Soak	950	—	57,000	89,000	8.5	B90	
Fe 1.0	—	—	—	—	—	—	—	—	

NOTES: See also Tables 4 and 5.

Excellent wear resistance of the aluminum bronzes lead to their extensive use as machine components. These duplex bronze gear blanks have been heat treated and are ready for machining. (Frontier Bronze Co.)

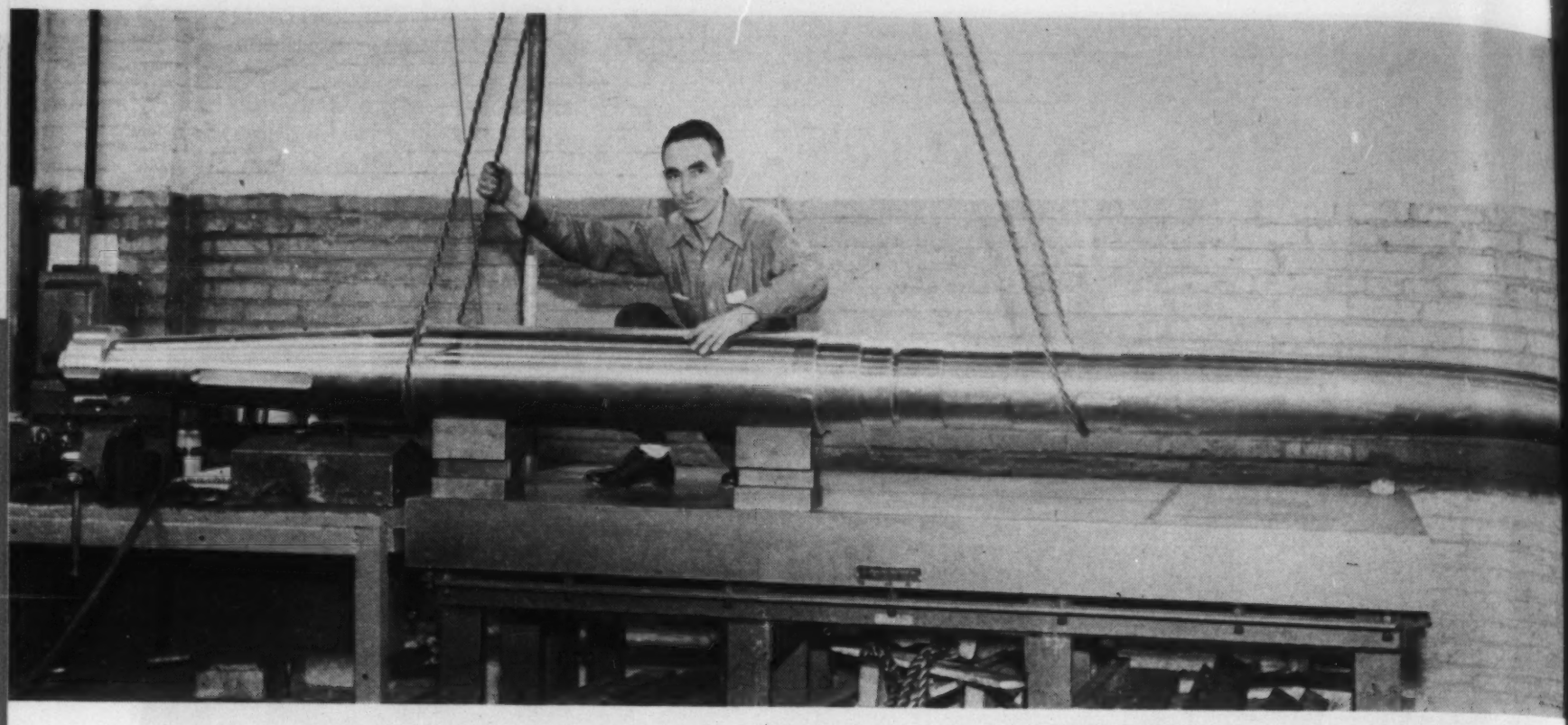
In machining aluminum bronzes, ample lubrication is required for best results. The function of the coolant is to lubricate as well as cool. Sulfur-free mineral oils containing 10 to 20% lard oil are frequently used because presence of sulfur in the oil may result in staining the work.

The aluminum silicon bronze listed in the group of standard alloys has somewhat different characteristics. Presence of silicon increases the machinability of this alloy. It has been given a rating of 60 to 65 by one group and thus is in the range of the readily machinable copper alloys. Another group takes exception to this rating and states that this material is only slightly easier to machine than some of the duplex alloys.

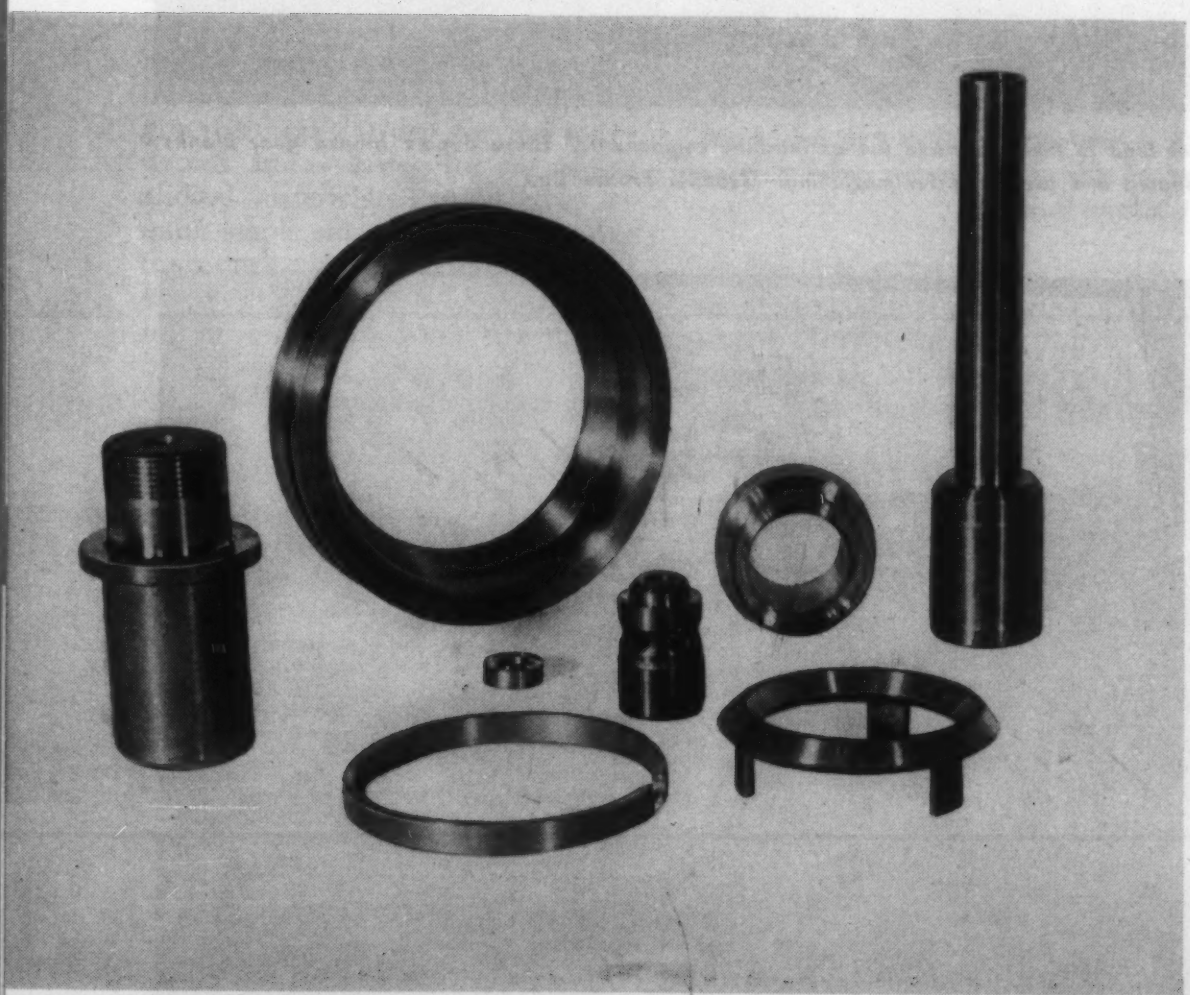
For aluminum silicon bronze, top rake angles of 6 deg with clearance angles of 5 to 10 deg have been used, while end mills can have a rake angle of 6 deg and a clearance of 12 deg. Cutting speeds often range from 200 to 300 sfm, and the work is flooded with a light paraffin oil to which 5 to 10% lard oil can be added.

Either high-speed steel tools or carbide tools are satisfactory for ma-

Continuous strip rolling mill bearing-segments and washers of aluminum bronze 9B. (Frontier Bronze Co.)



Forged marine propeller shaft of nickel aluminum bronze produced by Philadelphia Bronze and Brass Corp.



Aluminum silicon bronze valve seat rings and parts for an extrusion press hydraulic system operating at 1200 psi pressure. (Bridgeport Brass Co.)

chining aluminum bronzes. The choice of tool material is usually based on service requirements. For short runs and for roughing cuts, high-speed steel tools are generally used. Carbide tools, since they produce a finer finish, are used generally for finishing operations. They can also be profitably employed for long runs because they hold parts to closer tolerances for longer periods than steels.

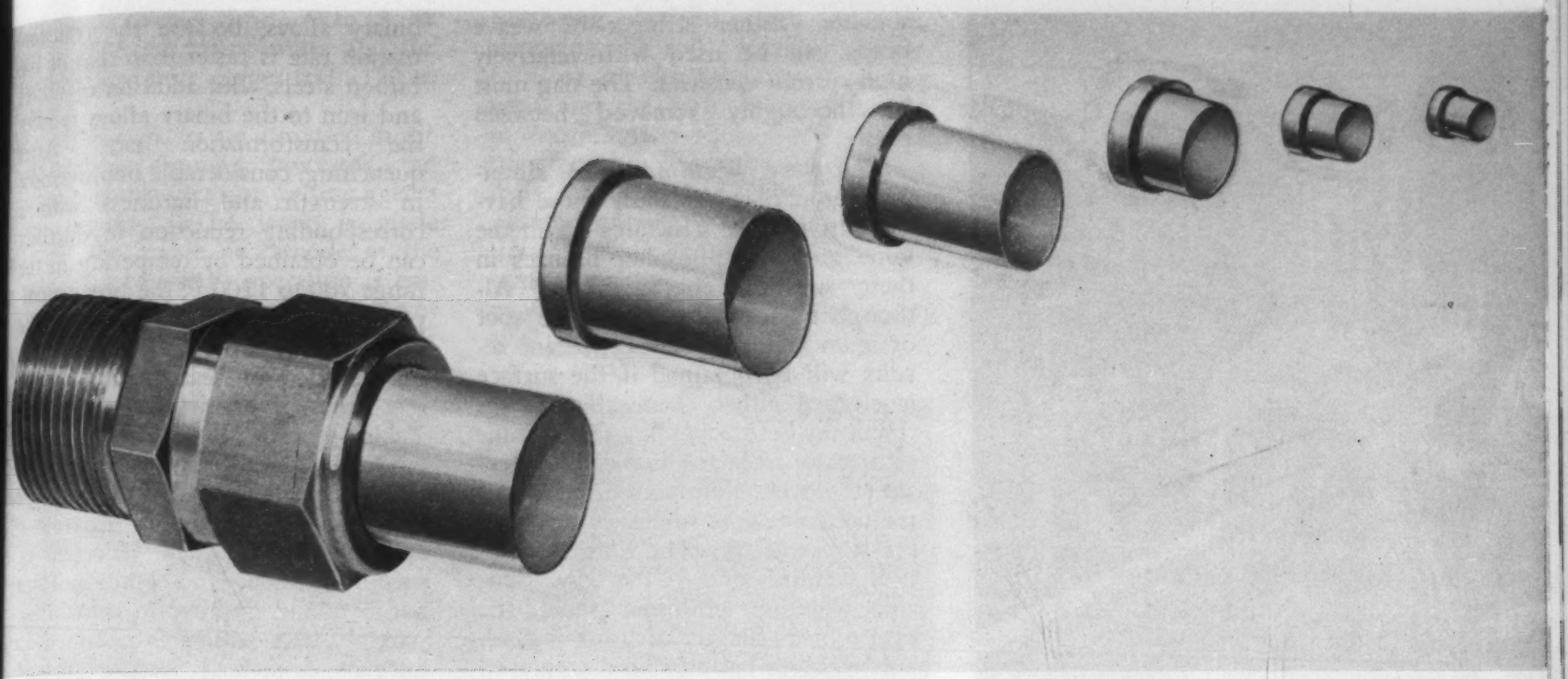
Joining

The tenacious skin of oxide which forms on aluminum bronzes introduces joining problems. Soft soldering and silver alloy brazing can be employed but are less commonly used than welding. Aluminum bronzes can be welded by a number of the established welding processes, but the various arc processes are most frequently used. Production of satisfactory welds by gas welding is difficult and this process is not considered to be commercially practical.

Soft Soldering—There is a difference of opinion on the suitability of soft soldering for joining of aluminum bronze. Some authorities state that satisfactory results can be obtained using 50 lead-50% tin solder and an active flux. Others state that soft soldering is not commercially practical.

Brazing—The aluminum bronzes can be joined with silver brazing alloys if special fluxes are employed. A number of proprietary fluxes are available. The best fluxes which have been developed are not suitable for certain other alloys and, therefore, when joints are made between aluminum bronzes and other metals, it is sometimes necessary to use two fluxes.

Carbon Arc Welding—This is one of the common methods of joining aluminum bronzes. To obtain good sound welds, coated filled rods must



Supporting sleeves for compression fittings used on airplane gas, oil and hydraulic lines produced on automatic screw machines from aluminum silicon bronze. (Bridgeport Brass Co.)

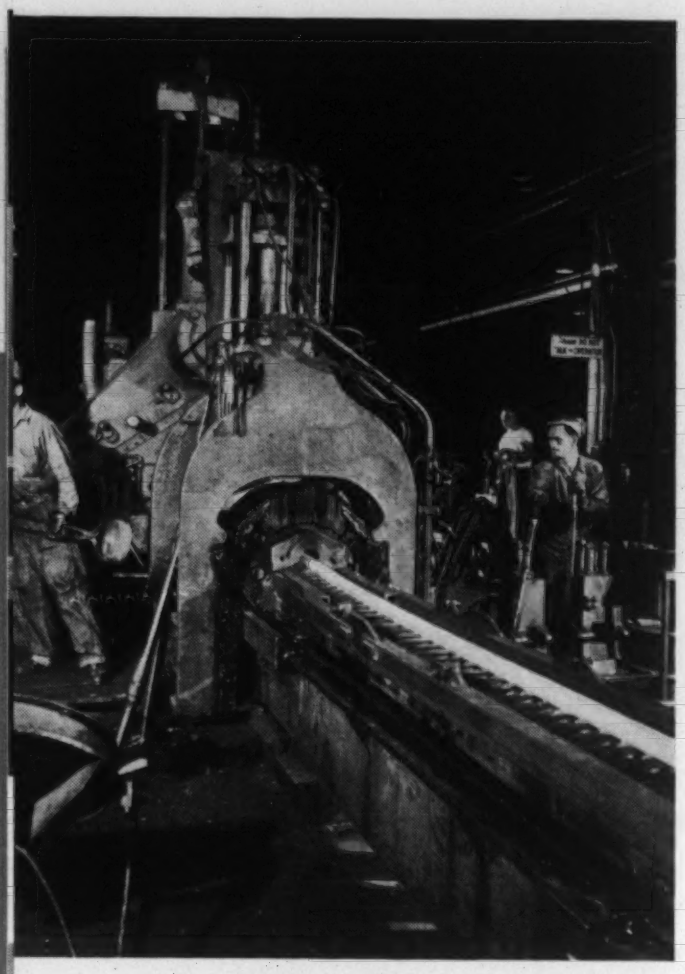
be used in order to achieve thorough fluxing of the oxide skin. Straight polarity direct current welding using standard carbon arc procedures in the flat position is recommended. For the low alloy grades, particularly in heavy sections, the work should be preheated to 300 or 400 F. For the more highly alloyed bronzes, preheating to 700 or 800 F is suggested to avoid cracking the deposit. No postheating is necessary for the low alloy grades, but the more highly alloyed materials should be annealed at 1150 F, followed by rapid cooling.

Inert-Gas-Shielded Tungsten Arc Welding—Aluminum bronzes can be welded by this process using either argon or helium atmospheres. An argon atmosphere gives a cleaner appearing weld deposit, while a helium atmosphere gives deeper penetration. Either alternating current, preferably with an argon atmosphere, or straight polarity direct current, preferably with a helium atmosphere, can be used, but better appearing welds are obtained with the alternating current procedure.

Inert-Gas-Shielded Metal-Arc Welding—This process, in which a consumable electrode is used, is rapidly gaining favor in welding the heavier gage materials because of the excellent weld deposits obtained and the high deposition rates. Either helium or argon shielding can be used. The same weld characteristics are obtained as in the gas-shielded tungsten arc process, and mixtures of the two gases are often used to combine the merits of each. Welding can be done using either forehand (gun pointing slightly toward the direction of travel) or backhand techniques. Backhand welding sometimes gives better control of penetration, although forehand welding results in cleaner, smoother appearing deposits.

Golden color of some aluminum bronzes leads to their use in tableware. Steps in the blanking and forming of a fork are shown in the foreground. Drawability of the material is indicated by the goblets and coffee pot. Joints in the latter are made by brazing. (Dirilyte Co. of America)

Shielded Metal-Arc Welding — Suitable electrodes are available for reverse polarity direct current and also for alternating current welding of aluminum bronzes by this procedure. Weld deposits have fair strength and ductility. Preheating is advisable, particularly on heavy sections, the temperatures suggested for use in the carbon arc process being



Extruded aluminum bronze bar on press run-out table at Ampco. Billet butt is being removed from the press.

Stator vane for the compressor end of a jet engine produced from aluminum bronze. (Behr-Manning)

suitable. Either stringer or weave beads can be used with relatively high current densities. The slag must be thoroughly removed between passes.

Resistance Welding—The aluminum bronzes, particularly those having single-phase structures are in the same group as phosphor bronzes in their welding characteristics. Although uncleaned stock can be spot or seam welded, more consistant results will be obtained if the surface is cleaned either chemically or mechanically before welding. If machine settings suitable for low carbon steel are employed, aluminum bronzes will require somewhat higher current and pressure settings. The shortest practical welding time is the best. Suitable welding conditions should be determined by actual tests. Flash butt welding has also been employed for joining aluminum bronzes with satisfactory results.

Heat Treatment

As mentioned previously, about 9.8% of aluminum is soluble in copper under equilibrium conditions, but under commercial conditions equilibrium is seldom attained and the practical limit is 8.4% aluminum. Alloys containing less than 8.4% aluminum have single-phase alpha structures and act like other single-phase copper alloys. They are hardenable by cold-working but not by heat treatment. These alloys can be annealed by heating in the range 800 to 1400 F, the grain size obtained in fully annealed material depending on the annealing temperature. Up to at least 1100 F, there is practically no scaling of the metal because of the protective oxide skin and any furnace capable of reaching the required temperature can be used.

Above 8.4% aluminum in the commercial alloys, a second phase, beta, appears. In the range from about 8 to 14% aluminum, a eutectoid transformation occurs at 1060 F and heat treatment is similar to that employed for steels. Thus, if these duplex aluminum bronzes are heated to temperatures above 1060 F and held for a sufficient length of time, the alpha phase dissolves in the beta phase. The temperatures used depend on the alloy and are generally in the range 1500 to 1800 F. Upon cooling, a structure resembling martensite is obtained if the critical cooling rate is not exceeded.

According to Vanick, it is difficult to obtain complete hardening in the binary alloys, because the transformation rate is faster than that of the carbon steels. But addition of nickel and iron to the binary alloys reduces the transformation rate. After quenching, considerable improvement in strength and hardness with a corresponding reduction in ductility can be obtained by tempering in the range 700 to 1200 F, the proper temperature being selected to suit the composition of the alloy. Some data on the effect of heat treating on the mechanical properties are included in Tables 4 and 10.

Duplex alloy castings are sometimes normalized by heating to 1500 F, cooling in the furnace to 1000 F and air cooling. The objective of such a treatment is to obtain uniform hardness and improve machinability.

Alpha-beta structures obtained in normal commercial practice are not in equilibrium and, upon prolonged heating to elevated temperatures, gradually transform to the stable alpha-gamma$_2$, form. The improvement in creep properties obtained by stabilizing the structure before testing is indicated by the work of Voce reported in Table 5.

Surface Finishing

Mechanical and Chemical Cleaning—Removal of oils, dirt, grease and metallic particles which are picked up on the surfaces of aluminum bronzes during fabrication can be accomplished in the manner employed with other copper alloys. Small parts can be cleaned by abrasive tumbling, followed by ball-burnishing if improved luster is desired. Large parts can be cleaned by dry or wet blasting, the choice depending on the nature of the cleaning operation and the dimensional accuracy required in the finished part. Dimensions can be maintained more accurately by use of suitably chosen wet procedures than by dry methods. The matte surface resulting from blasting forms an excellent base for lacquers or other coatings.

Among chemical cleaning methods, agitation in an alkaline bath is widely used. The compound is generally a mixture of caustic soda, phosphates, silicates and similar alkalies to which has been added organic emulsifiers and synthetic wetting agents. The bath is agitated to loosen dirt, while the alkali assists in cleaning by saponifying the animal or vegetable oils and emulsifying the mineral oils, thus removing them from the surface of the work. Commonly, the

solutions contain from 4 to 8 oz of cleaner per gal of water and the bath temperature ranges from 170 to 190 F.

Alkali cleaners are also used in the electrolytic cleaning processes, but neither emulsifiers nor wetting agents are required. The work is made either the anode or cathode in the cell, or a two-stage operation is employed. In the first, the work serves as the cathode, a rapid evolution of gas being obtained which assists in removing the soil. In this stage, 4 to 6 oz of cleaner per gal can be used and the bath operates at 160 to 200 F. After rinsing, the work is transferred to a second bath in which it is made the cathode. This bath usually contains a higher concentration of alkali, but is operated in the same temperature range. After removal from the second bath and rinsing, the surface of the work is chemically clean.

Solvent cleaning is used to remove oil from the surface of the work. The material is immersed in a low-boiling mineral oil fraction or a similar solvent, which is held at 120 to 140 F for sufficient time to remove the oils. Cleaning by this procedure leaves the surface physically clean. If a chemically clean surface is required, cleaning with an alkali cleaner must follow.

Vapor degreasing, usually with trichlorethylene, removes oils and greases rapidly from the surface. The part is placed in a suitable chamber in which the solvent vapor is condensed. The condensate flows over the part, removes oil from the surface, and leaves part clean and dry.

Pickling—Aluminum bronzes are somewhat different from most other copper alloys because of the protective oxide film. This oxide is not soluble in the usual acid pickling solutions. Therefore, when parts are pickled, the oxide-free areas are attacked more rapidly than protected areas since attack on the latter area occurs only by penetration of acid under the skin. Care must be taken to avoid spoiling the appearance of the work.

Pickling solutions usually contain from 5 to 10% sulfuric acid. After pickling, the work is generally rinsed and brightened by dipping either into nitric acid or into a sodium dichromate-sulfuric acid solution.

Welding formed aluminum bronze plate by the inert gas shielded metal arc process using bare aluminum bronze wire of similar characteristics. (Ampco Metal, Inc.)

Applications

The major applications of the aluminum bronzes are based on their good mechanical properties, chemical resistance, retention of strength at elevated temperatures, wear resistance and nonmagnetic properties.

Wear resistance is responsible for the selection of aluminum bronzes in many applications. These can be broken down loosely into bearings, machine parts, forming dies and overlays.

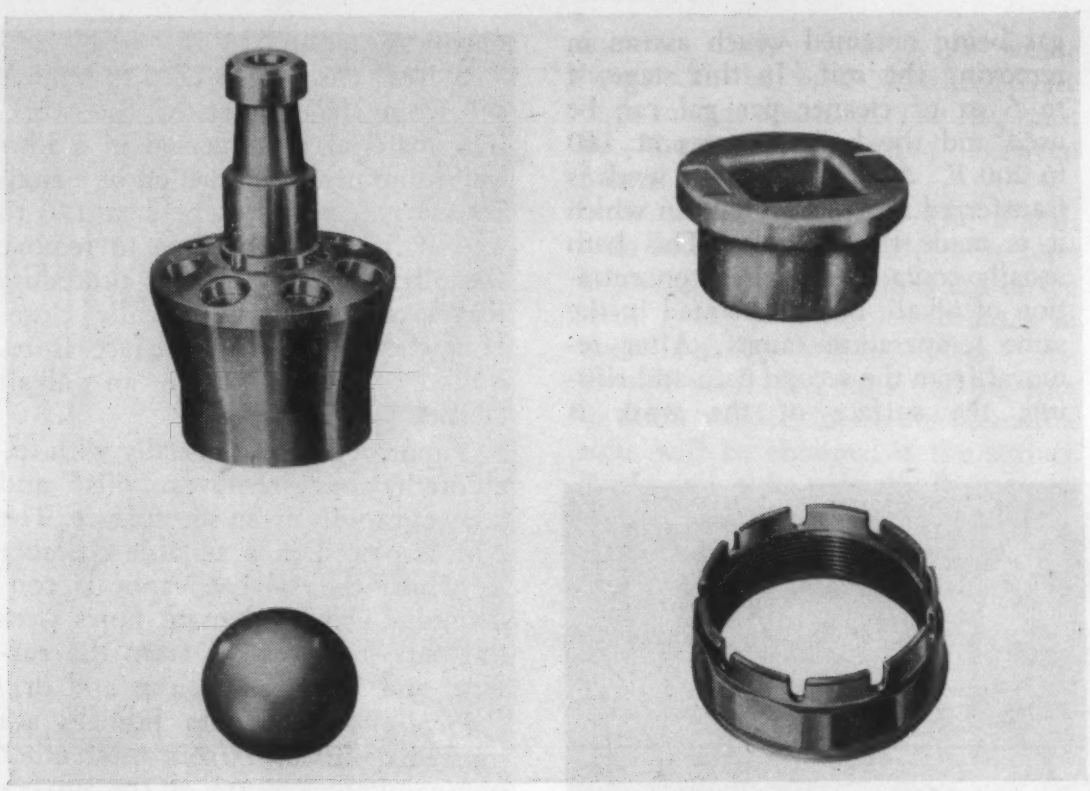
Various grades of aluminum bronze are used for guide bearings, spherical and rod-end bearings, guide pin bushings, pintle bearings in rolling mills, and many other services. They cover the field from small sizes to the massive rolling mill bearings which weigh several hundred pounds.

In the field of machine parts, spur, bevel, internal gears, worm wheels, slides and cams are representative. Welding machine jaws and other parts are also frequently made of aluminum bronze.

The low unit weight, good strength and good resonance factor have led to the use of aluminum bronzes in the aviation industry. It has been stated that aluminum bronzes are twice as effective in damping vibrations as steel. Applications in this field include forgings of various types, valve seats and guides, propeller blade bushings and retaining nuts, landing gear components, cam rollers, gun mountings and gun slides.

The stronger aluminum bronzes have found application in forming dies, particularly for use with stainless steels. For such service, in addition to their wear resistance, aluminum bronzes have adequate compressive strength and the great advantage of a low coefficient of friction in contact with the steels. Thus, galling and scoring are reduced to a minimum.

One of the major applications of the aluminum bronzes is the overlaying of steel parts to provide wear resisting surfaces. The hard grades of filler rods are used. These rods can be applied readily to high carbon, alloy and tool steels and to some grades of cast iron. The overlay is applied by the consumable electrode or carbon arc processes, and a firm bond is obtained because the bronze penetrates the pores of the underlying metal. Overlaying with aluminum bronze welding rods has been applied not only for rebuilding worn



Machine parts of various types are produced from aluminum bronze. (Mueller Brass Co)

gears and other machine parts but also for increasing the wear resistance of new equipment. In one application, the life of roller bearing shoes for locomotive service was more than doubled by replacing the phosphor bronze inserts used previously with aluminum bronze overlays.

Three grades of aluminum bronze welding rods are available for service in joining various materials. Two contain iron in addition to copper and aluminum, the third contains no iron. They are used for joining aluminum bronzes of similar compositions, copper-zinc alloys, ferrous alloys, and combinations of dissimilar metals. Because of their wear resistance, the iron-bearing grades, together with three others developed specifically for the purpose, are used extensively for overlays, the grade being selected on the basis of the severity of the service requirements.

Aluminum bronzes have good high temperature mechanical properties which, combined with their scaling resistance, have led to a number of applications. Because of these properties, aluminum bronzes have been used for gears and bearings subjected to high temperatures, heat exchanger equipment, cylinder heads, valve sleeves for internal combustion engines and similar applications.

In the chemical field, aluminum bronzes are used particularly because of their resistance to mineral acids and their retention of strength at elevated temperatures. They are employed as heat exchanger, evaporator and condenser tubes, fractionating tower parts such as bubbles caps and risers, pump parts and fans for handling acid vapors. Autoclaves and other unfired pressure vessels are produced from aluminum bronze because of a combination of strength and corrosion resistance.

In the paper industry, aluminum bronze blades have given excellent service in the handling of sulfite pulp. Equipment for pickling tanks such as chains and hooks has been made of aluminum bronze, cast products being preferred by some authorities on the ground that they resist corrosion fatigue to a greater degree than the wrought products.

Resistance to sea water and salt air is the basis for the use of aluminum bronzes in marine service. The nonmagnetic properties of these alloys are advantageous also in certain marine applications. Such applications include pump casings and shafts, valve fittings, propellers and trim.

Aluminum bronzes have practically no tendency to spark when struck, and this property leads to the application of some of the stronger alloys in the production of nonsparking tools. Such tools, including chisels, shovels, hammers, wrenches and shears, have reasonably long life and are employed in the explosive, paint and similar industries where an explosion hazard exists.

Other applications include the use of a special 2½ aluminum bronze for electrical applications and the use of various grades for decorative trim, since the alloys offer a wide range of colors from white to golden yellow.

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Materials Engineering File Facts

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Number 240

LIMITING CREEP AND STRESS RUPTURE VALUES

Material	Condition	Temp, F	Stress, 1000 Psi for: 1% Deformation in: 0.01 Hr	0.1 Hr	1 Hr	10 Hr	100 Hr	2% Deformation in: 0.1 Hr	1 Hr	10 Hr	100 Hr	10% Deformation in: 0.1 Hr	1 Hr	10 Hr	100 Hr
309	2000 F, 30 min.	1200	—	—	—	—	—	19	17.8	16.4	—	—	34.8	27	22.6
		1500	9.4	5.7	—	—	15	10.1	7.8	*5.7	—	—	12.5	8.3	—
310	2000 F, 30 min.	1200	—	—	—	—	—	—	24.7	21.5	—	—	—	*26.2	—
	Air-cooled	1600	9.8	6.8	5.3	—	—	10.2	7.4	5.3	—	—	9.5	*6.1	—
314	2000 F, 30 min.	1200	—	*18.5	*16	—	—	*23.5	21.2	18.5	—	—	35.6	28.8	—
	Air-cooled	1400	12	10	*8.7	—	19.5	14.8	12.2	*9.5	—	—	*19.6	11.2	—
		1600	7.2	6.3	5.2	—	10.6	7.8	6.4	3.95	—	—	8.5	5.35	—
		1800	—	3.9	3.35	2.95	—	4.3	3.7	3.2	—	—	4.4	—	—
316	2000 F, 30 min.	1200	—	—	—	—	*17	16.8	16.5	16.2	15.4	*40	33.5	28.0	23.5
	Air-cooled	1400	—	12	6.4	5.1	—	14.2	12	7.4	*6.3	—	18.2	13.4	*9.4
		1500	—	9	4.9	—	—	11.5	7.8	5.0	3.88	—	13.2	9.3	6
		1600	—	4.9	*3.8	—	12.4	7.5	4.9	*3.85	—	*14	9.8	5.9	*3.8
		1800	3.78	2.2	*1.28	—	6.2	3.8	2.22	—	—	6.5	3.6	1.9	—
321	Annealed	1200	23	20.5	*16	—	—	25	21.5	*16.8	—	—	*32	22	—
		1500	—	5.4	—	—	—	—	6	4	—	—	—	5.3	*3.7
347	Annealed	1200	—	21	19	—	*30	28	26.2	23.4	—	—	*36	27.5	—
		1400	15	12	—	—	—	17.6	13	—	—	*22	16.5	—	—
		1500	11.3	7.5	*2.45	—	15.2	11.8	7.2	2.85	—	15.4	10.3	5.7	—
		1600	7.4	—	—	—	12	8.4	4.2	—	—	11.5	6.8	*3.4	—
Haynes Stellite No. 25	2200 F, 20 min. Air-cooled	1500	—	22	12.8	—	—	29	20	13	10.2	—	27	19.6	*14.3
		1800	—	5.8	*4.3	—	*15	10	6.8	4.8	—	*14.4	10.2	6.6	—
Haynes N-155	Annealed	1500	—	—	—	—	27	21.5	17.5	*14	—	29	22	*17	—
		1800	—	—	—	—	—	8.3	5.7	*3.8	—	—	7.4	4.6	—
Inconel-X	Aged 24 hr, 1550 F	1200	—	—	—	—	—	*81	*74	—	—	88	80	—	—
	Aged 20 hr, 1300 F	1500	—	—	22.6	*17	—	—	—	—	—	*42	29.8	*22	—
		1800	3.65	*2.65	—	—	*5.6	3.68	—	—	—	—	*5.2	3.15	*2.25
24S-T	Solution treated and cold-worked	300	—	—	—	—	—	—	—	—	—	59	58	56	—
		450	—	—	—	—	—	31.5	25.5	18.5	—	32.5	27	19.5	—
		600	—	—	—	—	—	11	8.1	5.25	—	12	9	5.95	—
FS-1H Magnesium	Hard-rolled	300	6.25	2.8	—	—	*13.5	8.1	4.2	—	—	—	9.7	6.6	3.5
		450	1.65	0.4	—	—	5.2	1.65	*0.5	—	—	—	3.3	1.6	—

* *Extrapolated.*

Materials Tested

Material	Sheet Thickness, In.	Condition	Rockwell Hardness	Composition
SAE 1095 (a)	0.054	Hot-rolled, annealed	C25	C 0.90–1.05 Mn 0.30–0.50
		1750 F, oil-quench, temp, 1000 F	C46–50	P 0.040 S 0.050
		1450 F, oil-quench, temp, 1000 F	C34	
SAE 4340	0.051	Normal, 1600 F, temp, 1000 F	C36	C 0.43 Mn 0.70
		Normal, 1600 F, temp, 1200 F	C24	Si 0.30 Ni 1.76
		Normal, 1600 F, temp, 1300 F	B100	Mo 0.27 Cr 0.78
SAE 6150	0.057	Annealed at 1550 F	B96	C 0.50 Mn 0.87
		1550 F, oil-quench, temp, 1000 F	C39	Si 0.29 Cr 0.85 V 0.18
		1550 F, oil-quench, temp, 1200 F	C28	
SAE 8630 (a)	0.052	Annealed	B82	C 0.28–0.33 Mn 0.70–0.90
		1600 F, oil-quench, temp, 1000 F	C32–34	Si 0.20–0.35 Cr 0.40–0.60
				Ni 0.40–0.70 Mo 0.15–0.25
Mayari-R	0.051	Annealed	B76	C 0.12 Cr 0.40
				Mn 0.50 Ni 0.25
				Si 0.10 Cu 0.50

(*Continued on page 143*)

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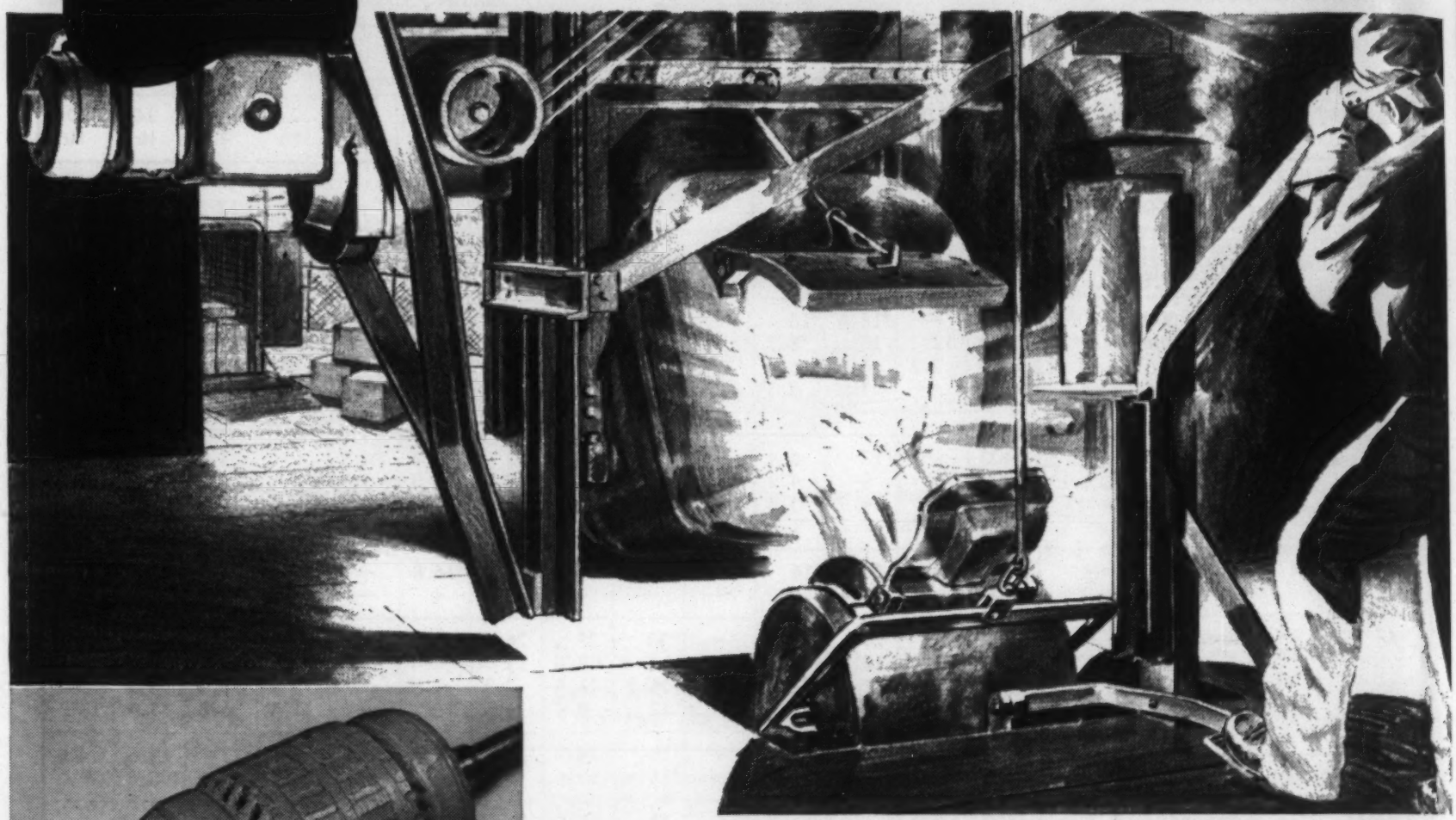

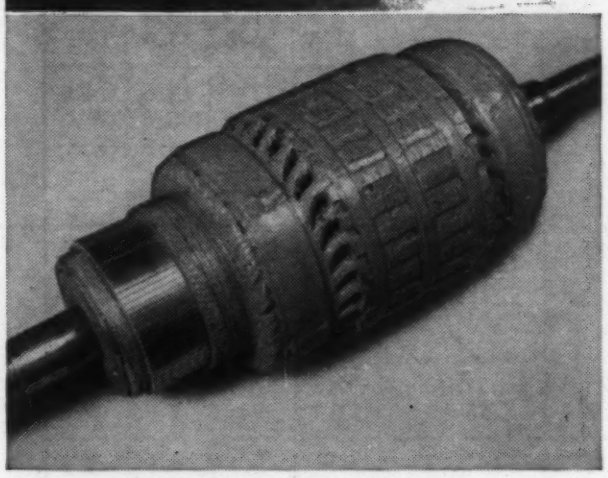

Class H motor outlasts Class A 10 to 1 in spite of high ambients, heavy duty and accidental stalling.

Subjected to continuous 24 hour duty to meet increased production schedules, the 4½ hp dc Class A insulated transfer crane motors in a large midwestern foundry had a service life of only 2 to 3 months. Life for these overworked motors was further complicated by trips to the furnace at least once every 15 minutes where ambient temperatures run as high as 180° F.

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MATERIALS & METHODS
December • 1952
Number 240

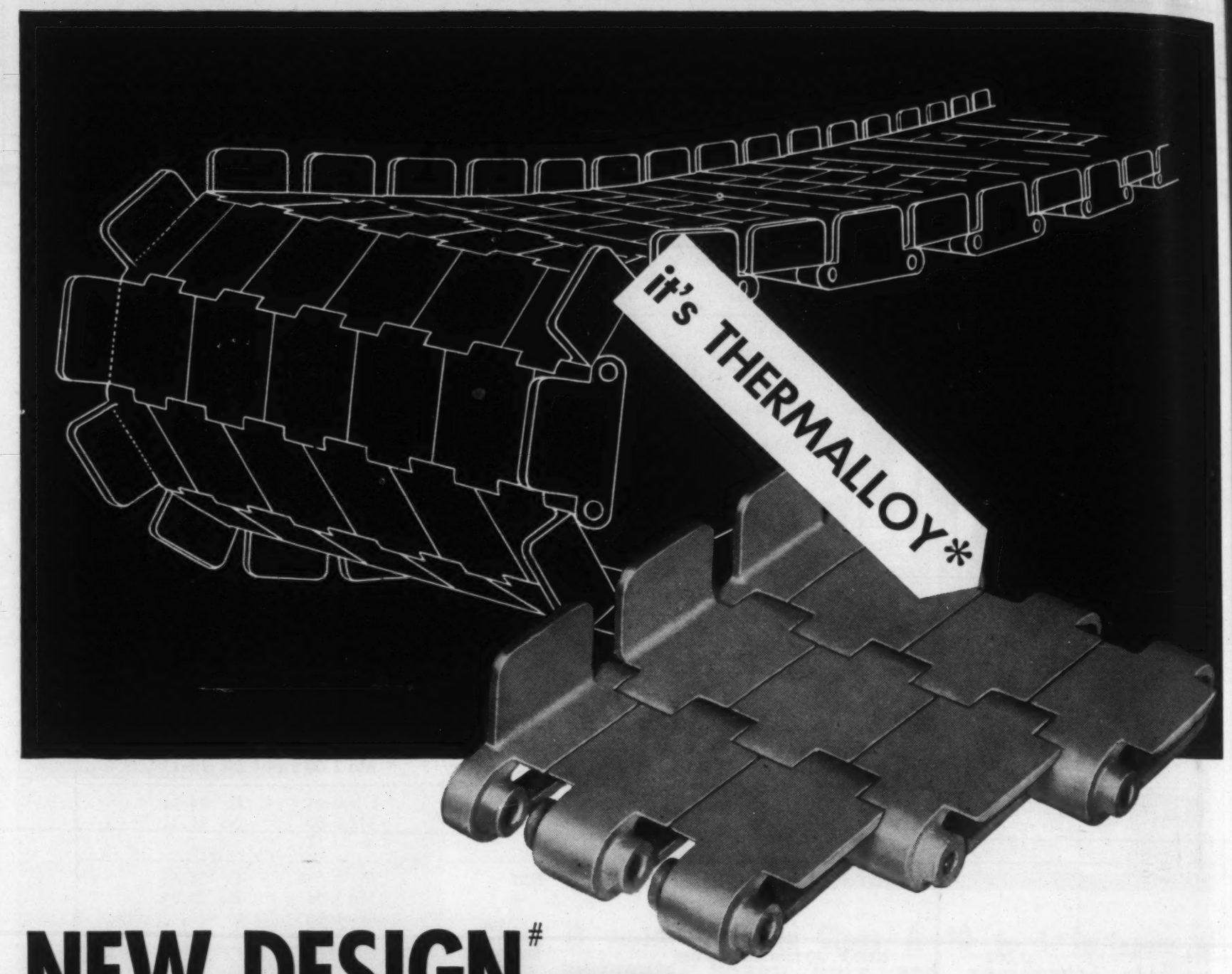
NUMBER 240 (continued)

LIMITING CREEP AND STRESS RUPTURE VALUES

Material	Sheet Thickness, In.	Condition	Rockwell Hardness	Composition
17-22-A	0.055	Anneal at 1600 F Normal, 1600 F, temp, 1000 F Normal, 1600 F, temp, 1200 F	B96 C45 C36	C 0.46 Mn 0.48 Si 0.074 Cr 1.25 Ni 0.20 Mo 0.54 Co 0.16 V 0.31
Aluminized SAE 1008 (a)	0.053	Aluminized by hot-dipping	B75	C 0.10 P 0.040 Mn 0.25–0.50 S 0.050
SAE 1025 (a)	0.055	Annealed	B78	C 0.22–0.28 P 0.040 Mn 0.30–0.60 S 0.050
3 Cr-1 Mo Ti-B	0.050	2100 F, H_2 10 min. Air-cooled	B103–107	C 0.07 Cr 2.91 Mn 0.34 Ti 0.14 Si 0.28 Mo 1.06 B 0.022
302 (a)	0.047	2000 F, Air-cooled. Half-hard	B78–80 C35–37	C 0.08–0.20 Cr 17–19 Ni 8–10
302B	0.070	2000 F, 30 min. Air-cooled	B85–87	C 0.10 Cr 17.82 Mn 1.66 Ni 8.90 Si 2.16
309 (a)	0.062	2000 F, 30 min. Air-cooled	B70	C 0.20 max Cr 22–24 Mn 2.00 max Ni 12–15
310	0.047	2000 F, 30 min. Air-cooled	B74	C 0.05 Cr 24.54 Mn 1.80 Ni 21.21 Si 0.52
314	0.054	2000 F, 30 min. Air-cooled	B70	C 0.059 Cr 24.62 Mn 1.96 Ni 21.24 Si 1.88
316	0.062	2000 F, 30 min. Air-cooled	B69–72	C 0.05 Cr 17.81 Mn 1.55 Ni 13.08 Si 0.84 Mo 2.34
321 (a)	0.034	Annealed	B77–79	C 0.08 max Ni 8–11 Cr 17–19 Ti 5xC min
347	0.051	Annealed	B82	C 0.074 Cr 17.60 Mn 1.62 Ni 11.03 Si 0.35 Cb 0.77 Cu 0.08
Haynes Stellite No. 25	0.066	2000 F, 20 min. Air-cooled	B95–97	C 0.13 N 10.0 Mn 1.5 W 15.0 Si 0.40 Co rem Cr 20.0
Haynes N155	0.055	Annealed	B89–94	C 0.20 max Mo 3.5 Cr 20.0 Co 20.0 Ni 20.0 W 2.5 Cb 1.25 N 0.15 Fe rem
Inconel X	0.052	Aged 24 hr at 1550 F, aged 20 hr at 1300 F	B107	C 0.04 Cb 1.00 Mn 0.42 Ti 2.54 Si 0.41 Fe 6.58 Cr 14.84 Al 0.64 Ni 73.46 Cu 0.02
24S-T3	0.064	Solution treated and cold-worked	F97–99	Cu 4.5 Mn 0.60 Mg 1.5 Al rem
FS-1H Magnesium (a)	0.065	Hard-rolled	F76	Al 2.5–3.5 Zn 0.6–1.4 Mn 0.20 min

(a) *Nominal Composition.*

Adapted from a report by G. J. Guarnieri and J. Salvaggi, Cornell Aeronautical Laboratory, Inc., For Project Squid, sponsored by U. S. Navy and U. S. Air Force.



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First—this design of link eliminates "crankshafting".

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For full information on this improved Thermalloy conveyor design, contact your nearest Electro-Alloys representative. Or write Electro-Alloys Division, 2084 Taylor Street, Elyria, Ohio.

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New Materials and Equipment

Porcelain Finish for Steel Offers New Possibilities

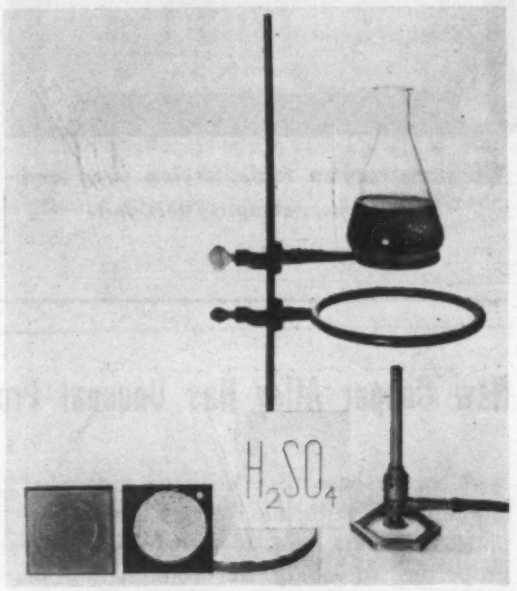
A new high acid resistant porcelain enamel coating for steel has been announced by *Seaporcel Metals, Inc.,* 28-20 Borden Ave., Long Island City 1, N. Y. According to the company, the coating, CRC-14, will withstand a boiling of 1% sulfuric acid solution with a weight loss of only 1 milligram psi in a 24-hr period. This compares with weight losses of 5 mg psi in only a 2-hr period for previously developed acid resistant ceramic coatings.

Thermal shock tests have shown that CRC-14 can withstand five cycles at 800 F, compared with 600 F for other finishes. Characteristics of the new finish when applied to low carbon steel are said to compare favorably with those of stainless steel, and the finish is expected to provide an excellent substitute for stainless steel in many applications.

Possible applications of the new material include use for vats and piping in food, chemical, pharmaceutical or bacteriological industries. It is particularly well suited for flue linings exposed to acid fumes, where frequent sharp temperature changes are necessarily encountered.

Combined with new Seaporcel laminating methods to provide rigid backing, it will also serve as a suitable, lighter-weight substitute for stone or brick in the construction of workable tops.

The company is ready to produce the finish on steel to meet any requirements or specifications at a cost only slightly higher than ordinary porcelain enamel. The coating is available in any color or texture, and is easily cleaned with a mild soap solution. Furthermore, it requires no painting.



Porcelain finish withstands a boiling of 1% sulfuric acid solution.

Powdered Metal Bevel Gears Have High Tensile Strengths

Michigan Powdered Metal Products Co., Inc., Northville, Mich., has announced that it is now producing in high volume bevel gears made of powdered metal. These gears are of an iron or steel base and are said to have high tensile strengths to provide excellent wearing qualities. When desired, they can be impregnated with oil with a resulting marked reduction in noise when compared with steel gears.

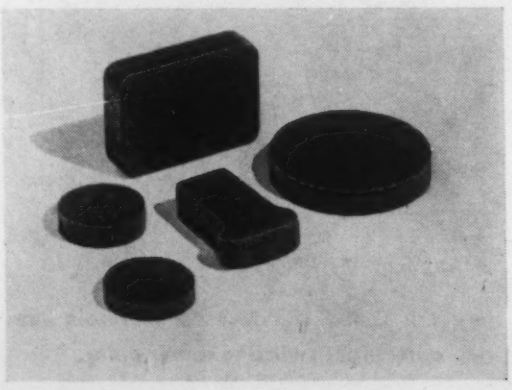
Because of the manufacturing processes involved, these powdered metal bevel gears are extremely accurate by comparison with gears produced by hobbing. If required, they can be hardened.

Currently, the gears are being manufactured on a contract basis only, and in sizes from the smallest up to an outside diameter which, under normal circumstances, is approximately 4 in. In the case of bevel rings, with the usual correspondingly larger inside diameters, sizes larger than 4 in. can be produced.

Phenolic Molding Compound Can Be Automatically Preformed

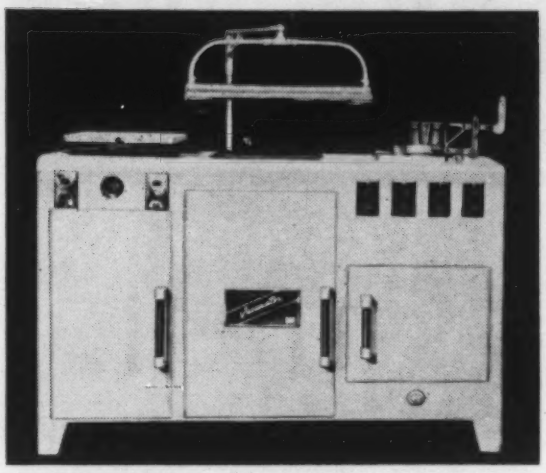
RX-431, a phenolic molding compound with a minimum impact strength of 1.05 lb per in. of notch, has been announced by *Rogers Corp.,* Manchester, Conn. The new compound is designed to meet the materials requirements of Military Specifications of MIL-P-14B.

Available in black and natural colors, the compound can be automatically preformed on a standard tabletting machine. Preforms can be held to close tolerances. The high strength material can be compression, transfer or plunger-molded. The low bulk factor of the material, approximately 3.5:1, and uniform pellet size make possible precise volumetric loading and also permit use of relatively shallow molds, two advantages that reduce cost of producing large molded parts.



Phenolic compound can be compression, transfer or plunger molded.

New Materials and Equipment continued



Vibrator, vacuum table, drying oven and melting pots comprise this unit.

All-in-One Unit for Fast Production of Master Patterns and Samples

Vibrator, vacuum table, drying oven and melting pots, all conveniently combined in one unit is currently available from *Guy P. Harvey & Son Corp.,* Leominster, Mass. Called a Vacurator, the unit has been specially designed to benefit makers of dolls, toys, lightweight plastic items, or novelties. It does this by letting them make their own master patterns from original models, and then using these to make immediate samples while the permanent cavities are being made.

The unit's compact completeness places everything required at the operator's fingertips. Therefore, rapid production of the following is said to be effected: Plaster molds from the original model—from the plaster mold, immediate duplicate models from sheet stock, using the Vacurator's infra-red lamps and vacuum table, can be made; kirsite cavities for immediate sample production; master patterns of Cerobase or Dental Stone—from the plaster molds, to obtain low cost stainless or beryllium-copper pressure cast cavities and cores; cast resin patterns for duplicating machines.

New Copper Alloy Has Unusual Properties

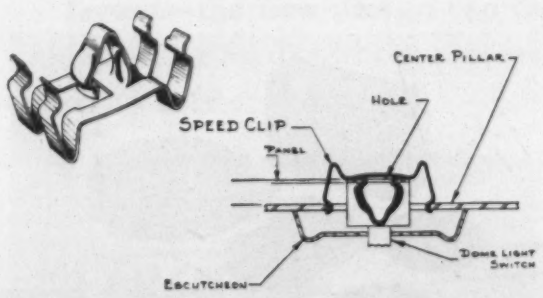
A copper-base alloy utilizing controlled amounts of tellurium, nickel and phosphorus that is said to provide unusual properties including the combination of excellent machinability, hot and cold workability, good electrical conductivity, high strength, age-hardenabitlity, high fatigue strength and good corrosion resistance, is currently available from *Chase Brass & Copper Co.,* Waterbury 20, Conn. A patented Chase alloy, it is called Telnic bronze.

The superior physical and electrical properties of Telnic bronze and its suitability for hardening by heat treatment, hot working or forging without loss of good electrical conductivity are said to be due to the accurately proportioned amounts of nickel and phosphorus which must be used in combination. Good machinability, equal to 80% of free-cutting brass, is obtained by the addition of a controlled amount of tellurium. The use of tellurium does not present the disadvantage of hot shortness characteristic of leaded, high copper alloys.

According to the company, the alloy can be as readily hot pressed or hot forged as most high copper lead-free alloys, and has properties that are superior to other high copper machinable alloys, including leaded copper and leaded commercial bronze. In as-forged or soft condition, it can be satisfactorily cold worked. In hard temper it can be swaged, headed or bent to a degree which is appreciable but limited by cold work of the final drawing operation.

Typical use of Telnic bronze include forgings and screw machine parts requiring high strength, hardenability, extensive machining, corrosion resistance and high electrical conductivity, or any combination of these properties. Tool forms required for machining the alloy are similar to those used for free-cutting brass, but the use of carbide tips is recommended for prolonging tool life. Commonly used cutting speeds range from 200 to 400 fpm, and the use of lubricants or cutting fluids is recommended to remove heat, minimize abrasion and erosion, to improve surface finish and for the removal of chips.

The new product is supplied as round rods ⅛ in. to 1¾ in. in dia, or as hexagonal rods measuring 3/16 to 1¼ in. across flats. Rods supplied are of uniform quality and temper, sound, smooth, clean and commercially straight.



Here the speed clip is used to retain the dome light switch to center pillar.

New Fastener Simplifies Difficult Assembly

Better and faster mounting of assemblies in blind locations which allows access from only one side is said to be made possible by a new clip developed by *Tinnerman Products, Inc.,* Cleveland. Typical of the many company fasteners which simplify this difficult kind of assembly, the new clip is used to retain the dome light switch to the center pillar on an automobile.

Made of spring steel material and heat-treated, the new clip C20655-017, affords a fast and simple assembly. The dart portion of the clip is inserted into a 0.187-dia hole in the dome light switch. The switch is then snapped into the center pillar panel, completing the assembly. There are two Speed Clips in each unit.

According to the company, the new clip assembles much faster than the old method, which required driving sheet metal screws. It eliminates the possibility of stripping screw threads, sharply reduces assembly costs, and gives a cleaner design because all fastenings are hidden.

Heliarc Torch for Heavy-Duty Machine Welding Introduced

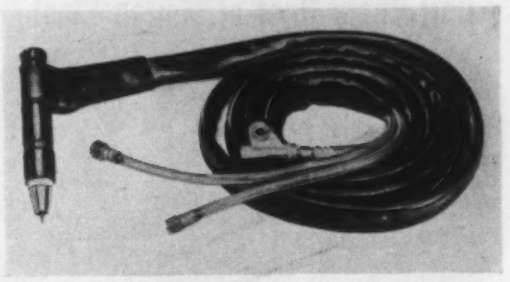
A more efficient and economical Heliarc torch for heavy-duty machine welding has been introduced by *Linde Air Products Div., Union Carbide and Carbon Corp.*, 30 E. 42nd St., New York 17. The new HW-13 torch is light in weight and can be mounted on any machine carriage that provides proper speed control for repetitive straight-line, shape, girth seam or portable welding operations.

Gas leakage and contamination by air are claimed to be prevented by specially designed gaskets used throughout the torch. Design of the HW-13 also minimizes stub loss of expensive and hard-to-get tungsten electrodes.

Efficient cooling of the torch body, welding head and gas cup is brought about by water passages inside the torch body. Water flows unimpeded through these internal passages down to the water jacket and gas cup and out again through the power cable, keeping the torch cool under the most severe welding conditions. All water passages are easily accessible for cleaning.

Welding nozzles are replaceable without taking the torch apart. The range of nozzle sizes provides ample gas flow for all operations requiring up to 500-amp welding current.

The torch body is covered with a tough, long-wearing plastic, and internal current-carrying parts are well-protected to prevent electric shock and accidental arcing.



Designed for heavy-duty machine welding, this Heliarc torch has a rated capacity of 500 amp.

Synthetic Rubber Offers Interesting Possibilities

Greater tire wear is a distinct possibility in the near future if a new type of GR-S synthetic rubber, now in the pilot plant stage, becomes a production reality. The new rubber was developed by scientists of the *Naugatuck Chemical Div., U. S. Rubber Co.*, Rockefeller Center, New York 20.

Laboratory tests show that the new synthetic gives 30 to 50% more abrasion resistance than standard "cold" rubber. It also has good resistance to heat, cracking caused by rapid flexing, as well as the deteriorating effects of being aged in air.

Preliminary road tests for tires made with the rubber appear to be confirming the improvements found in the laboratory, although no final answer has yet been determined. The new rubber is made possible by the addition of rosin chemicals to an extra tough "cold" type of GR-S synthetic rubber. The rosin chemicals make the rubber easier to fabricate into products and improve its end product qualities. The chemicals are added to the rubber when it is in the latex or liquid form. Carbon black, the principal reinforcing agent for rubber, can also be added at the same time.

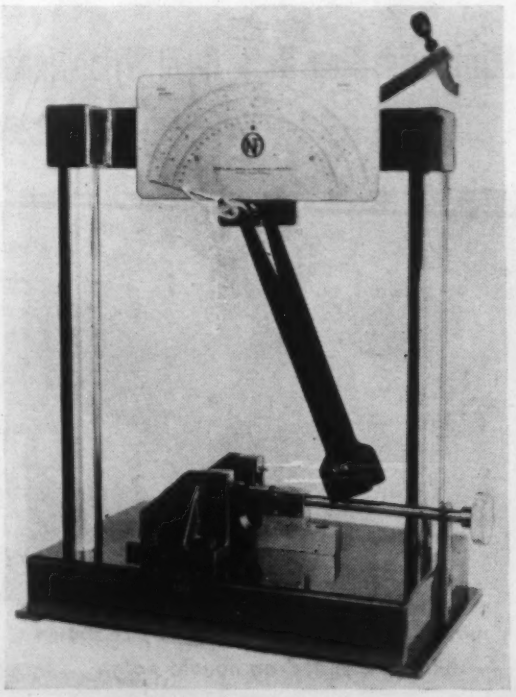
Impact Tester for Plastics, Ceramics, Light Metals

A new three-capacity range impact tester especially designed for testing plastics, ceramics and light metals has been announced by the Machine Div., *National Forge and Ordnance Co.*, Irvine, Warren County, Pa. The unit was developed to provide a wider capacity range in making standard tests of plastics and electrical insulating materials. Accuracy rigidly conforms to Federal Specification L.P. 406a and ASTM Standard D 256.

Another objective was to provide a maximum of clearance and open working space around the specimen rest and vise. This makes for convenience, especially in making tests at subnormal or supernormal temperatures, when it is desirable to locate the specimen refrigerator or oven adjacent to or surrounding the specimen holders.

The machine makes either the Izod (cantilever beam) or Charpy (simple beam) test on each of its three capacity ranges. A separate hammer is provided for each of these tests in each capacity range, *i.e.*, six hammers in all. The hammers are quickly and conveniently interchangeable, being firmly secured to the ball bearing spindle by two hardened screws. Calibration of the hammers as regards statis weight, balance and concentration of mass at the striking point is, of course, done individually.

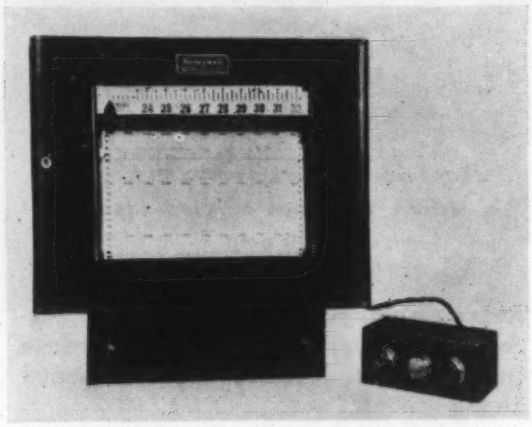
Each hammer is one welded or riveted unit with the striking bit a permanently integral part. The possibility of variable errors due to energy absorption by screwed-on weights and detachable bits is said to be eliminated



This impact tester tests plastics, ceramics, light metals.

New Materials and Equipment continued

Unit Tests Heat of Molten Steel



This unit tests heat of molten steel.

An electronic detecting device that is expected to markedly improve measurement of molten steel temperatures, an essential step in predetermining the quality of steel, has been developed by the Industrial Div., *Minneapolis-Honeywell Regulator Co.,* Wayne & Windrim Aves., Philadelphia. Called a balance detector, the new device uses fast-acting immersion thermocouples. In field tests in a half dozen steel mills, the company reports that the method brought reductions in the cost for the temperature taking operation as well as greater accuracy of the measurements. In one mill, it was reported that the cost for each temperature reading the conventional way was five dollars; utilization of the new device dropped the cost to 20¢.

The instrument extends the life of the immersion thermocouple assembly (the unit which is repeatedly thrust into the molten steel) by as much as 100%. This is done, company engineers explain, by holding to an absolute minimum the time the unit is immersed in the hot steel. In addition, its increased sensitivity has speeded up the entire temperature reading operation, reducing the reading by some 75% in many instances.

The unit, when immersed in the molten steel, signals the operator at the precise moment the maximum, or true reading is obtained. Previously, operators had to guess at this and consequently tended to leave the unit immersed in the steel too long. This usually resulted in outright disintegration of the expensive platinum thermocouple and was one of the big drawbacks for universal adoption of the immersion thermocouple technique for steel temperature measurement.

Pre-Plating Conditioner for Zinc-Base Die Castings

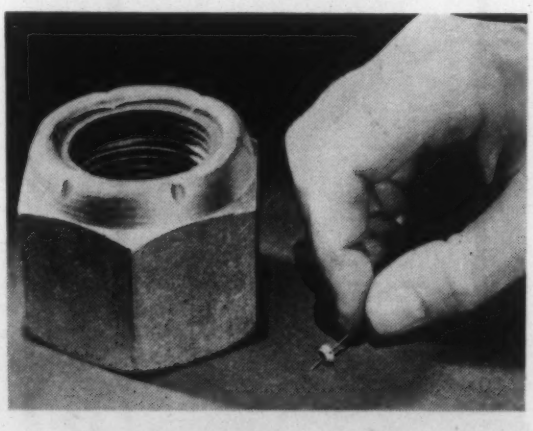
Oakite Products, Inc., 132H Rector St., New York 6, has announced a new electrolytic conditioner for zinc-base die castings in preparation for plating. Designated Oakite Composition No. 95, the new conditioner is said to have the following advantages:

1. Fewer rejects—the product removes the surface films, disturbed metal and last traces of soil that are among the major causes of peeling and blistering. It is also claimed to avoid the hydrogen gas formations that raise blisters when castings are heated after electroplating. Tests indicate that no blisters appear in plating on sound surfaces during the severe test of 1 hr of baking at 300 F.

2. Brighter plating—anodic conditioning with No. 95 removes all films that might impair the brightness of subsequent electroplates. The controlled, uniform action is said to eliminate undersurface shadows caused by the deep etching of harsh cleaners. The composition, according to the company, rinses so freely that even with dry-down times as long as 1 min. (as in automatic plating) no residue films will appear on the castings.

3. No blackening during anodic cleaning—castings do not lose their brightness during the evenly-controlled Oakite Composition No. 95 conditioning process.

Miniature Stop Nuts Have Nylon Inserts



A miniature nut with nylon insert is shown here suspended on needle point.

A new line of miniature hexagonal stop nuts, as small as 0.109 in. across flats, has been introduced by *Elastic Stop Nut Corp. of America,* 2330 Vauxhall Rd., Union, N. J. The nuts have nylon locking inserts and will be available in brass and aluminum. Believed to be the first integral locking collar type of self-locking nut manufactured to such minute dimensions, they compare with a dimension of 0.250 in. across flats for the smallest ESNA nut previously made.

The nuts are expected to find wide use in specialized applications, particularly in the electronics and instrumentation fields. They are said to make possible precise adjustments, whether tightened against a seating surface or simply located at any predetermined point on a threaded member. The nylon locking insert maintains a constant and highly reusable grip on the screw threads, unaffected by vibration. The simplicity of this one-piece approach is a great production advantage.

The nuts are already being tested by a number of manufacturers for such products as servo-mechanisms, walkie-talkies, and autopilots. They are expected to find use in the electronic brains which control guided missiles.

The line of miniature nuts includes correct dimensions for watchmakers' standards for No. 00, Nos, 1, 2 and 3 nuts. Type 1660 are currently being made in sizes 0 through No. 4. Most of these are available in both National Coarse and National Fine threads.

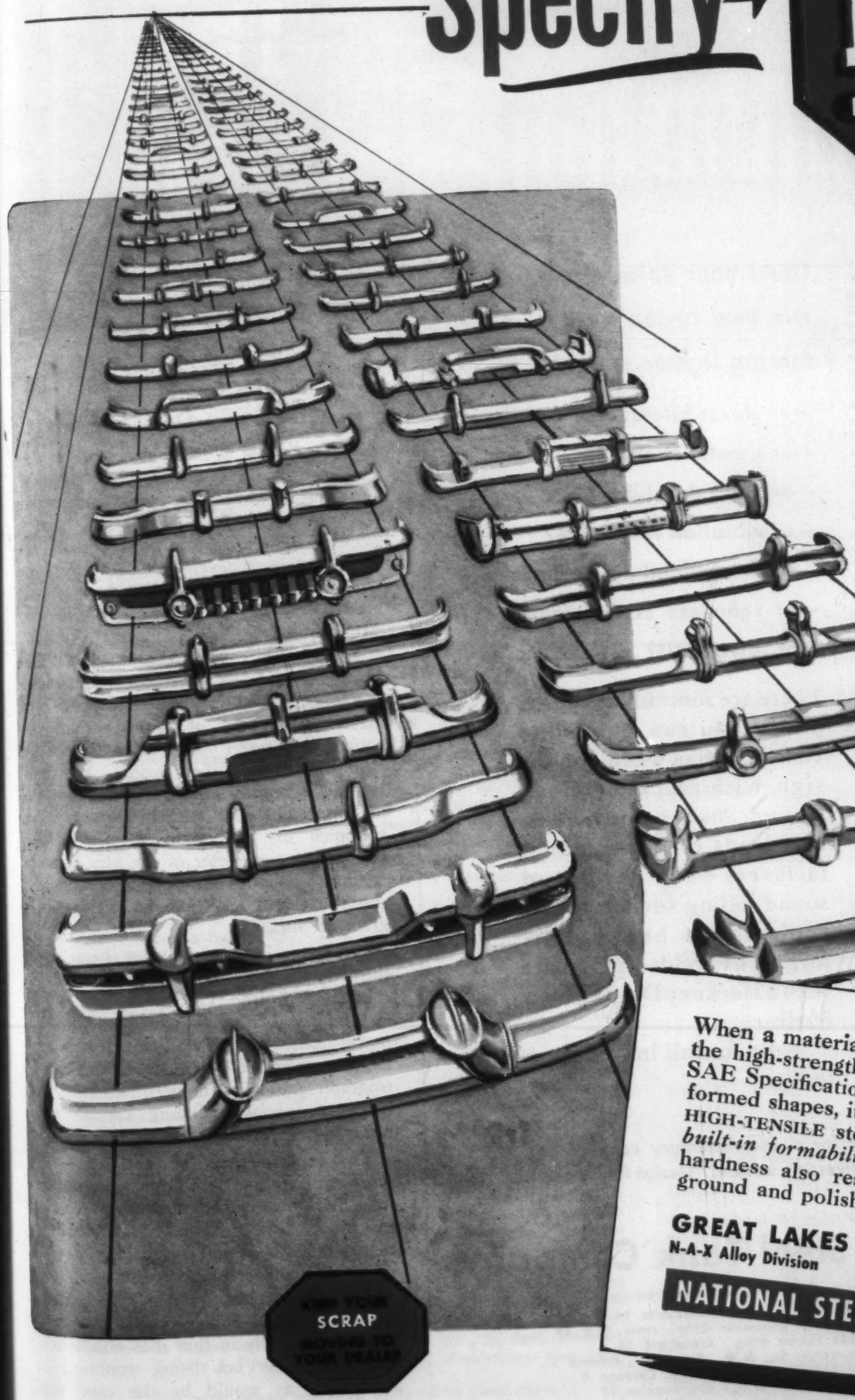
(More News on page 150)

When a high-strength steel is needed

for severe cold-formed shapes like these bumpers

Specify→ N-A-X HIGH-TENSILE STEEL

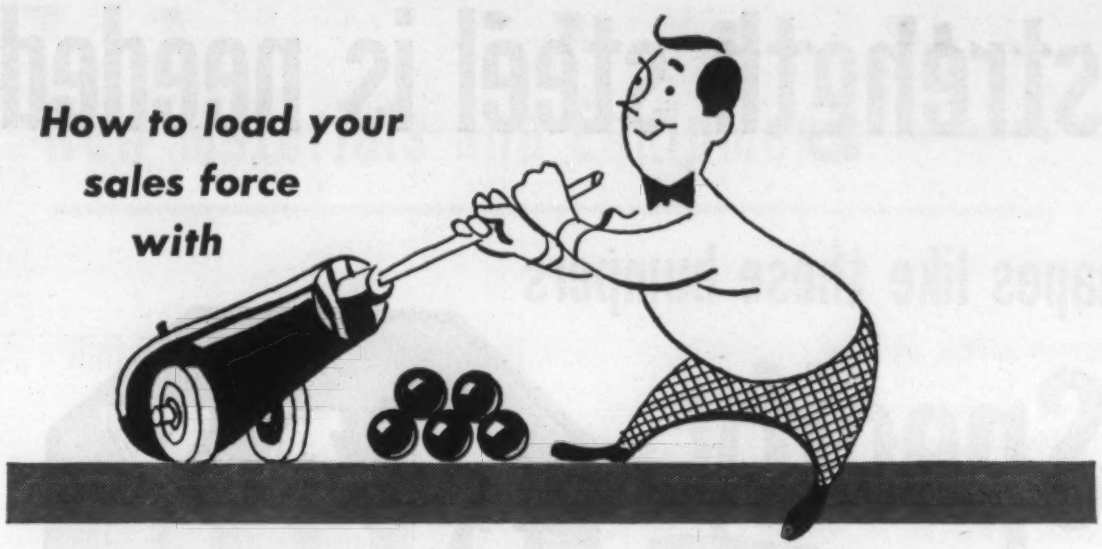
and get all of the requirements of SAE 950



When a material meeting the requirements of the high-strength, corrosion-resisting steels of SAE Specification 950 is used for severe cold-formed shapes, it will pay to investigate N-A-X HIGH-TENSILE steel—the low alloy steel with *built-in formability*. Its finer grain and higher hardness also result in brighter luster when ground and polished for plated parts.

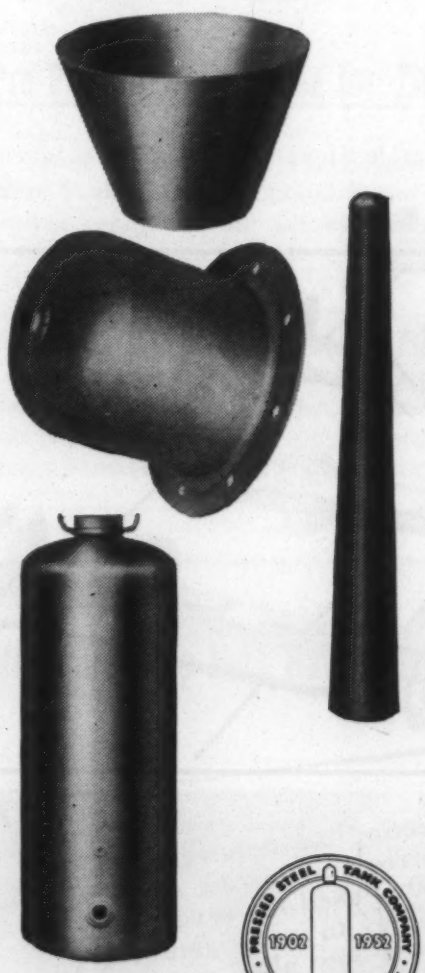
GREAT LAKES STEEL CORPORATION
N-A-X Alloy Division
Ecorse, Detroit 29, Mich.

NATIONAL STEEL CORPORATION



new ammunition

**HACKNEY
DEEP DRAWN PARTS**
have been designed in many shapes and sizes—in capacities from 1 quart to 150 gallons. Here are a few typical examples:



Could your salesmen win new customers by talking lighter weight?

—or closer tolerances?
—or greater strength?
—or extra durability?
—or vibration resistance?
—or streamlined appearance?
—or seamless construction?
—or lower cost?

These are some of the selling points you can build into your products when you design with Hackney Deep Drawn Shapes and Shells. Hundreds of other manufacturers have developed sound selling advantages by replacing a heavy cast, forged, or welded pipe part with a Hackney Deep Drawn Shell.

Write for full information today.

Ask for a complimentary copy of our anniversary booklet, "Design for Progress."

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Pressed Steel Tank Company

Manufacturer of Hackney Products
1442 S. 66th St., Milwaukee 14
1319 Vanderbilt Concourse Bldg., New York 17
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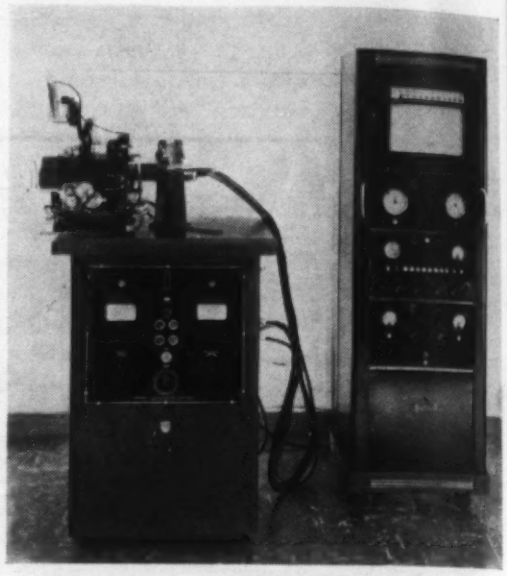
936 W. Peachtree St., N.W., Room 111, Atlanta 3
208 S. LaSalle St., Room 788, Chicago 4
559 Roosevelt Bldg., Los Angeles 17

CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

New Materials and Equipment



New X-Ray Technique for Thin Coatings and Trace Elements

What is said to be a new, more powerful approach to difficult problems involving the identification and quantitative analysis of minute amounts of elements present in very thin film or small deposits has been developed by the *Research & Control Instruments Div., North American Philips Co., Inc.*, 750 S. Fulton Ave., Mt. Vernon, N. Y.

In laboratory tests dealing with thin films on stainless steel and component metals deposited on plastic and metal base materials, coatings of 6 micrograms per square centimeter or less were readily determined. In other words, the new technique readily determines percentages of chromium and nickel present in a specimen of 18:8 stainless steel where one square centimeter of the film actually contains about one microgram of chromium and less than one-half microgram of nickel.

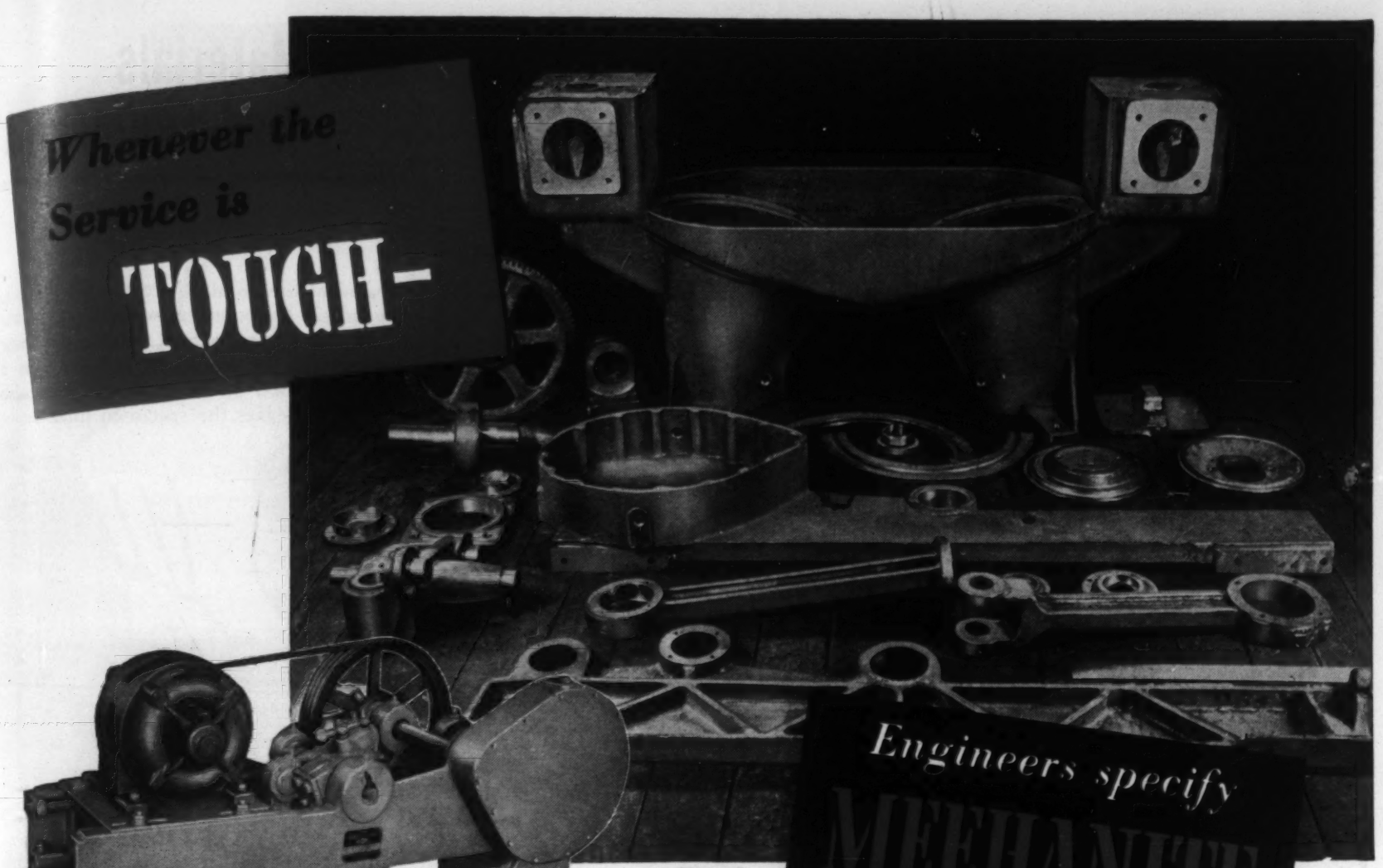
Numerous analyses have been performed by the company on specimens consisting of iron, chromium, nickel and stainless steel alloy deposited on films of mylar plastic and on lead foil. Instrumentation consists of a standard X-ray Spectrograph employing tungsten radiation, but using a special analyzing crystal with newly developed optics.

Each specimen is scanned with the X-ray Spectrograph and the spectrum recorded through an angular range suitable for the particular elements involved. Intensity measurements are made with the scaler and a fixed count operation.

According to the company, the method has a distinct advantage over former techniques, especially in that it is nondestructive, the films not being ruptured or dissipated, as would be the case with spark spectrographs. Furthermore, in the latter method, the film is ruptured or dis-

Whenever the Service is

TOUGH—



Engineers specify

MEEHANITE CASTINGS!

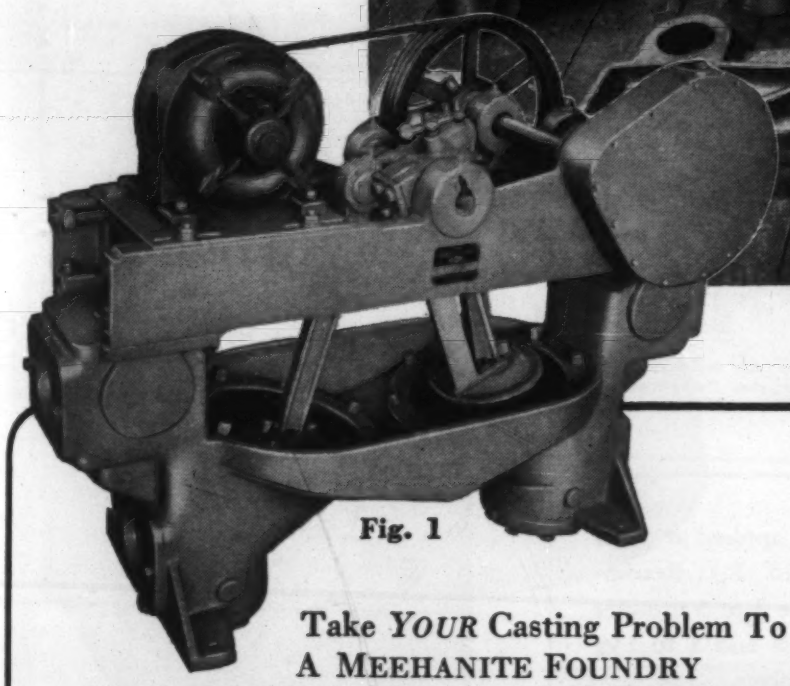


Fig. 1

Fig. 2

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Canton, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, Calif.
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

THE DORRCO V-type Diaphragm Pump (Fig. 1) manufactured by the Dorr Company, Stamford, Conn., was designed for handling sludges, pulps or slimes which contain sizable quantities of solid material. In keeping with their international reputation as builders of dependable and efficient equipment, designed to provide better service life under severe operating conditions, the Dorr Company regularly designs to and specifies Meehanite engineering characteristics.

Note that the Meehanite castings (Fig. 2) used in this specific unit reveal the fact that every major component is a Meehanite casting. These castings provide the necessary strength, toughness and resistance to wear and corrosion demanded by the service functions of such a pump.

Write for our new 20-page Pump Bulletin No. 36 which gives complete details not only on pump applications but various specific property tests as applied to impact, erosion, corrosion and wear.

MEEHANITE®

NEW ROCHELLE, N. Y.

AMERICAN CHEMICAL PAINT COMPANY
AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet
Subject: PROTECTING ALUMINUM WITH ALODINE®

"ALODINE" No. 100

"Alodine" No. 100 forms an amorphous phosphate surface on aluminum which is thin, tough, durable, non-metallic, continuous with and a part of the basis metal. The "Alodine" film anchors paint, prolongs paint life, and protects aluminum exposed unpainted to the atmosphere.

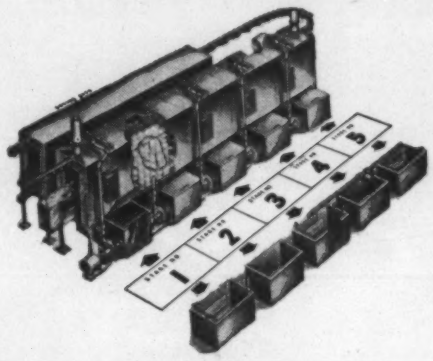
With the "Alodine" No. 100 bath at its normal temperature of 120° F., coating time by immersion approximates 1½ minutes—and by spraying, 15 to 20 seconds. Coating times and bath temperatures can be varied to suit operating conditions.

"ALODINE" No. 600

"Alodine" No. 600 forms corrosion-resistant coatings that provide excellent protection for unpainted aluminum and also make an effective paint-base. This grade is recommended for use in place of "Alodine" No. 100 on aluminum parts that are to remain unpainted or to be only partly painted; and on *all* aluminum castings and forgings whether or not these are given a paint finish.

"ALODINE" FLOW SHEETS

MULTI-STAGE POWER WASHER FOR SPRAY ALODIZING



IMMERSION TANKS FOR DIP ALODIZING

PROCESS SEQUENCE

1. Clean 2. Rinse 3. "Alodine" 4. Rinse 5. Final Rinse

NOTE: Equipment can be of mild steel throughout, except the "Alodine" stage which must be of acid-resistant material.

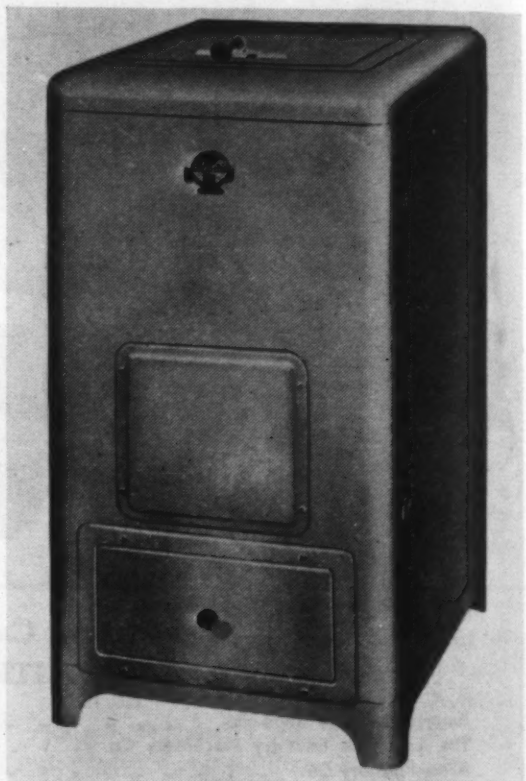
"Alodine" No. 600 is applied at room temperature (70° to 120° F.). Recommended coating times are 3 to 5 minutes for an immersion process and 1 to 1½ minutes for a spray process.

COATING DATA	"ALODINE" NO. 100	"ALODINE" NO. 600
COMPOSITION	Amorphous phosphate.	Amorphous mixture of metal oxides and chromates.
COLOR	Depending on alloy treated, color range is from an iridescent blue-green to a dark slate gray.	Depending on time of treatment, color range is from golden iridescent to light brown.
THICKNESS	From 0.01 to 0.08 mil. No appreciable dimensional changes occur when aluminum is Alodized.	From 0.005 to 0.01 mil. No appreciable dimensional changes occur when aluminum is Alodized.
WEIGHT	50 to 300 mgs. per square foot. Optimum: 100 to 200 mgs. per square foot.	35 to 50 mgs. per square foot.
SOLUBILITY	Insoluble in water, alcohol, solvents, etc. Insoluble in most dilute acids and alkalis. However, strong acids and alkalis which attack aluminum may penetrate the "Alodine" film and react with the underlying metal. Slightly soluble in concentrated nitric acid. Soluble in molten sodium nitrate, etc.	Insoluble in alcohol, water, solvents, etc. Soluble in strong alkalis and acids.
ELECTRICAL PROPERTIES	High dielectrical resistance.	This coating is electrically conductive. Aluminum coated with "Alodine" No. 600 can be shielded-arc welded or spot welded.
HEAT STABILITY	Unimpaired at temperatures that melt aluminum.	Unimpaired at temperatures that melt aluminum
FLEXIBILITY	Integral with and as flexible as the aluminum itself. Can withstand moderate draws.	Integral with and as flexible as the aluminum itself. Can withstand moderate draws.
ABRASION RESISTANCE	Approximately 90% of that provided by chromic acid anodized aluminum.	Approximately 90% of that provided by chromic acid anodized aluminum.
CORROSION RESISTANCE	Painted—superior to chromic acid anodizing. Unpainted—comparable with chromic acid anodizing. Meets MIL-C-5541 and other Government Finish Specifications.	Exceeds requirements of MIL-C-5541 and even AN-QQ-A-696a (anodic films)
PAINT-BONDING	Excellent. Equal to or superior to anodizing. Meets MIL-C-5541 and other Government Finish Specifications.	Excellent. Meets MIL-C-5541 and other Government Finish Specifications.
TOXICITY	Non-toxic.	Non-toxic.
BIMETALLIC CORROSION RESISTANCE	Shows good resistance against bimetallic or galvonic corrosion.	Shows good resistance against bimetallic or galvonic corrosion.

CHEMICALS ACP PROCESSES **WRITE FOR FURTHER INFORMATION ON "ALODINE" AND ON YOUR OWN ALUMINUM PROTECTION PROBLEMS.** CHEMICALS ACP PROCESSES

New Materials and Equipment

sipated at the point where the arc strikes, the metal evaporating with a resultant erroneous determination. Thus, the new method can be employed not only as a precise method of measurement, but also one which leaves the specimen intact.



CALCINATOR

Heat Resistant Finish Available in New Colors

Sicon, a silicone-base finish noted for its heat resistant properties, is now available in decorative colors from *Midland Industrial Finishes Co.*, Waukegan, Ill. The new formulations are said to stand up with excellent adhesion in the 400 to 500 F range without losing gloss and without powdering or losing color.

Color applications of the finish in tans, whites, beiges, blacks and golds have already passed stringent laboratory tests, according to company reports, and have also been proved on the production line. Predictions based on results so far is that Sicon will open up a new horizon to product engineers working on products for which it is desired to combine colorful eye appeal with retention of color and gloss in the presence of sustained heat.

An example of the success of the

put your parts in this profit picture with ROCKRITE TUBING

Compression sized to far closer tolerances than cold-drawn tubing, Rockrite Tubing cuts cost of parts . . . saves valuable machine time. Here's proof. • *One user halves honing time for hydraulic cylinders.* • *Another doubles output of ring-shaped parts with same machines.* • *Still another reduces machining chip losses by 64%. Also saves steel—gets more parts per pound.* • Want to know how you can put *your* parts in this profit picture with Rockrite Tubing? Send for Bulletin R2 which contains complete data.

Rockrite Tubing is made only by Tube Reducing Corporation, the originator of this process. You benefit by unequalled quality control methods.

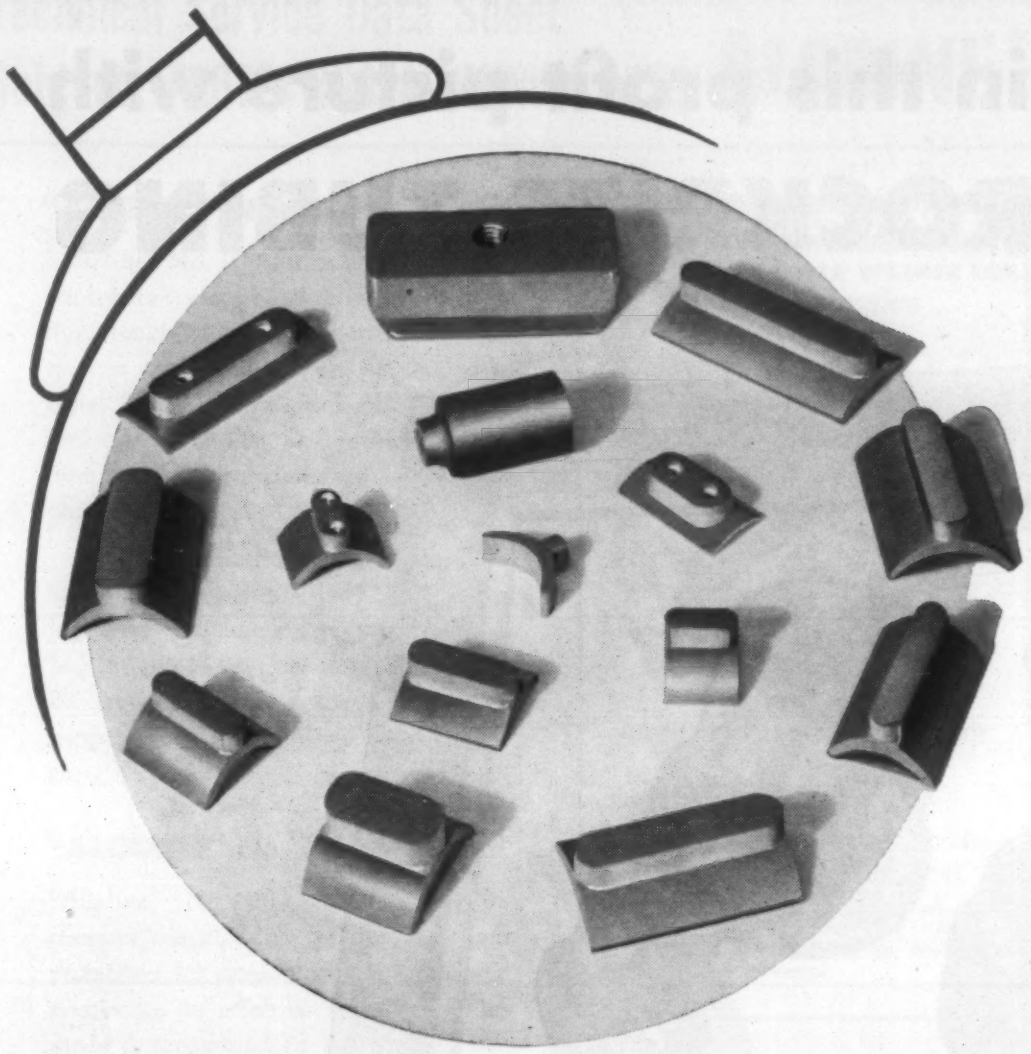
ROCKRITE® TUBING

ROCKRITE saves more than any other tubing

- *Higher cutting speeds*
- *Tools last longer between grinds*
- *Work-surface finishes are better*
- *Machined parts have closer tolerances*
- *Stations on automatics are often released for additional operations*
- *Extra-long pieces available — less downtime for magazine stocking and fewer scrap ends*
- *Closer tolerances often eliminate necessity for machining on outside or inside*

TUBE REDUCING CORPORATION · WALLINGTON, NEW JERSEY

for
ELECTROMAGNETIC USES



Parts of **POWDERED METAL**

Among the parts produced by Michigan Powdered Metal Products Company are pole pieces, stators and rotors used in fractional H.P. and D.C. motors, and instrument components.

Pole pieces provide an excellent example of how powdered metal can reduce costs and increase the operating efficiency of motors. By comparison with laminated parts, savings are realized in three ways . . . in elimination of expensive tooling . . . no scrap loss . . . and in economical design changes when they may be necessary. Because pole pieces of powdered metal are held to extremely close tolerances, gap clearances with the rotor are held to a minimum with the result that torque is increased with the same amount of current.

If you have need for powdered metal parts . . . large or small . . . simple or intricate . . . it can definitely be to your advantage to investigate the unusual abilities of Michigan Powdered Metal. Send us your parts prints for quotation.

Write for this bulletin describing our facilities and the scope of our powdered metal parts production.

MICHIGAN POWDERED METAL PRODUCTS COMPANY, INC.

476 CADY STREET • NORTHVILLE, MICH.

ALLIED PRODUCTS

Subsidiary of
ALLIED PRODUCTS CORPORATION

New Materials and Equipment

finish in colors is the experience of the Valley Welding & Boiler Co., Bay City, Mich., producers of the new Calcinator, a home incinerator and disposal unit. Reports of this company indicate that under rigid tests, Sicon was found to have high resistance to heat when exposed to temperatures ranging from 400 to 500 F, with exceptional color as well as gloss retention qualities.

New Finishing Process Eliminates Many Former Difficulties

Baked enamel and lacquer finishing of small metal parts from ½ in. to 2 ft in length, formerly possible only by the spray method, can now be achieved by a newly developed dipping process. Developed under the name of the Steingetz System by *Apex Stamping Co.*, 70 Marshall St., Newark 2, N. J., the process uses a hydraulic means of controlling the capillary action in the painting process.

The new method is said to turn out a better coating with complete controlled uniformity, and overall coverage, eliminating drip and tear marks.

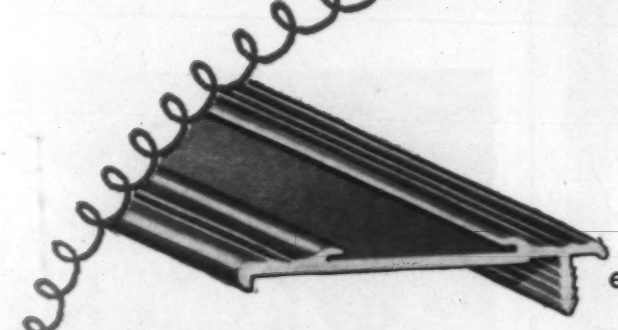
The new system has already been applied to the white metal casting industry, handbag frames, electronics, toys, communications equipment, and radio and television components.

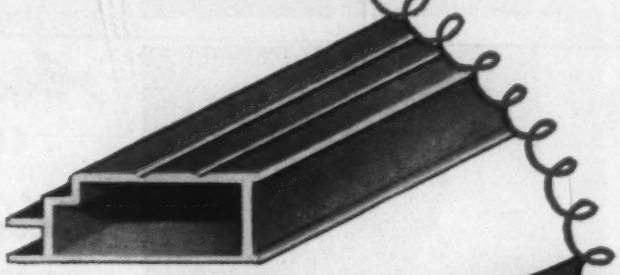
Corrosion Resistant Tank Liners

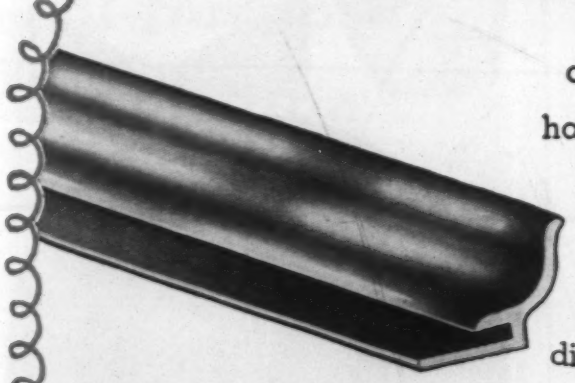
Corrosion resistant tank liners made of Agilene (polyethylene) and Agilide (unplasticized polyvinyl chloride) are now offered by *American Agile Corp.*, P. O. Box 168, Bedford, Ohio. These tank liners, which are of fully welded construction, are made to customers' specifications and can be furnished complete with drain and overflows, including Agilene or Agilide pipe flanges, fittings and valves, permitting incorporation into existing pipe lines and installations.

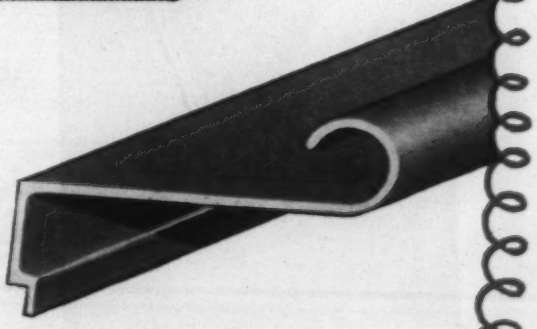
The chemical inertness of Agilene or Agilide and the welding method employed in the fabrication of such tank liners is said to insure a leak-proof liner,

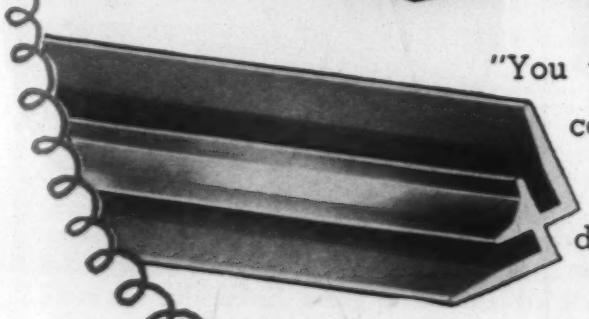
"We have found Youngstown Manufacturing to be a reliable source for Aluminum Extrusions"

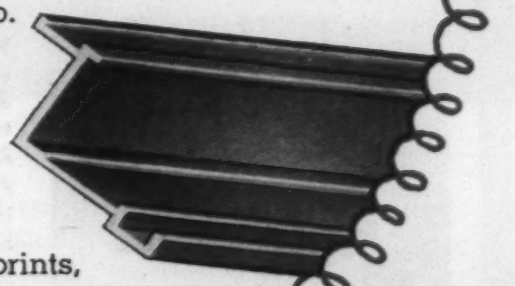












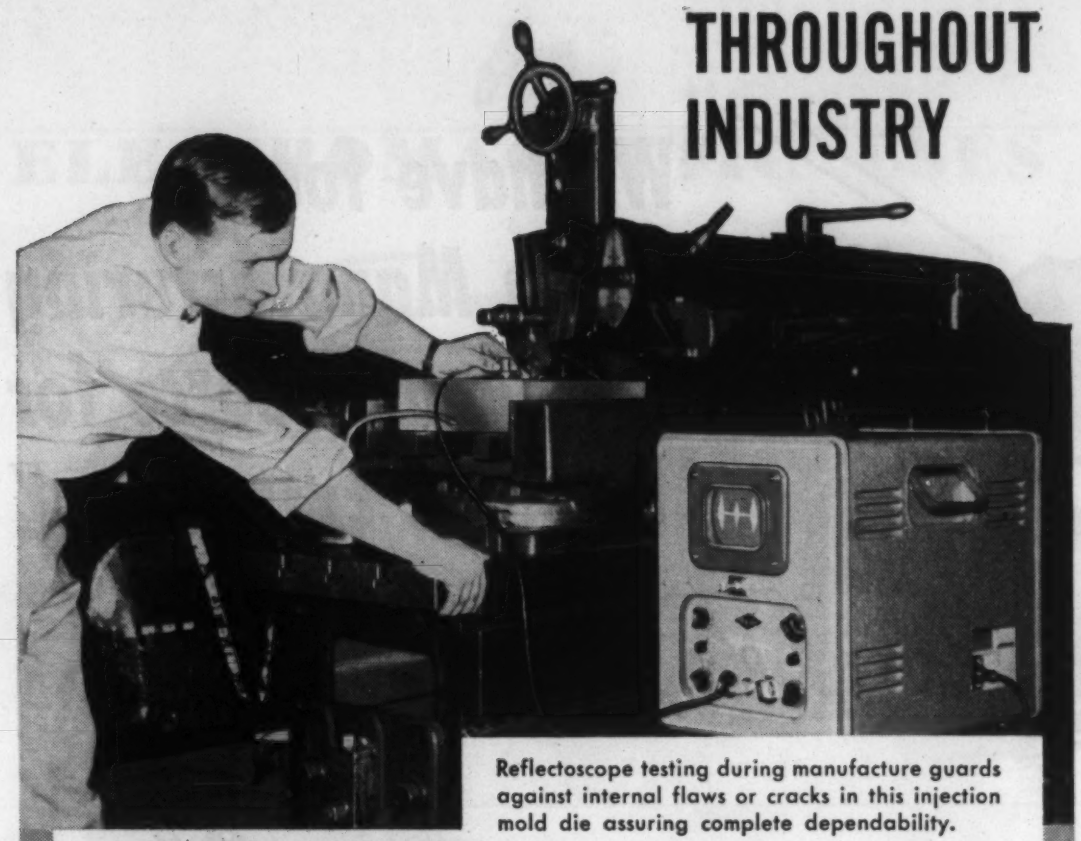
"You name the aluminum extrusion (or shape) you need and Youngstown Manufacturing can deliver. Chances are, they will have a die for the extrusion you need . . . (more than 400 on file). However, if you need assistance or engineering help on designing a special die, they have the manpower to do the job.

"You will find Youngstown Manufacturing can supply the aluminum extrusions you want, in quantity, on a dependable delivery schedule. Send prints, parts or information to Youngstown Manufacturing for prompt quotation."

SUPERIOR ALUMINUM EXTRUSIONS

Buy from the **BIG NAME IN ALUMINUM EXTRUSIONS**

YOUNGSTOWN MANUFACTURING, INC.
66-76 SO. PROSPECT STREET
YOUNGSTOWN, OHIO



Reflectoscope testing during manufacture guards against internal flaws or cracks in this injection mold die assuring complete dependability.

Reflectoscope testing prior to machining eliminates wasted time and loss of materials resulting from faulty metal.

Testing this large finished die assures freedom from internal defect and possible failure-in-use.

Assure
CUSTOMER SATISFACTION
Eliminate
WASTE • REJECTS
WITH
Sperry

ULTRASONIC TESTING

The Chicago Impression Die Company — makers of plastic injection mold dies — is one of the many firms throughout industry that has found two important benefits from Sperry Ultrasonic Reflectoscope testing.

First — Testing of raw materials before processing eliminates the many man- and machine-hours that are wasted when hidden flaws or inclusions are discovered during manufacture. Second — Reflectoscope testing the finished products assures that no flaws have developed that might cause failure in use. Customer acceptance and satisfaction is assured.

Simple, economical and effective in operation, the Reflectoscope penetrates up to 30 feet in solid metal with an ultrasonic beam that dependably detects and locates hidden internal flaws, defects and inclusions.

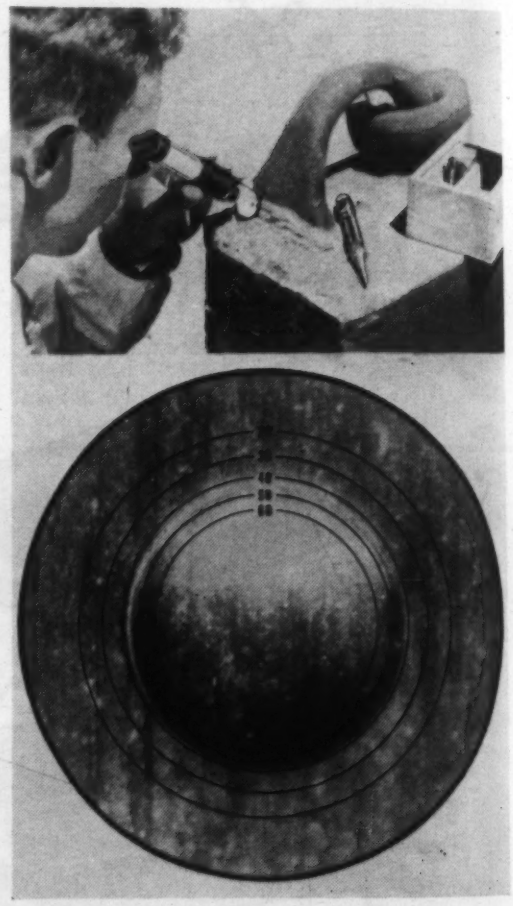
Write today for complete information; learn how you can reduce testing costs and improve quality control in your plant. The Sperry Reflectoscope is available through Sperry's convenient, economical, in-plant Testing Service, conducted by Sperry's experienced Inspection Engineers. Ask for details concerning sale or rental of the Sperry Ultrasonic Reflectoscope.

Sperry
SPERRY PRODUCTS, INC.
412 SHELTER ROCK ROAD
Danbury, Connecticut
REPRESENTATIVES IN PRINCIPAL CITIES

New Materials and Equipment

and to reduce maintenance and replacement costs of storage, make-up and plating tanks containing corrosive liquids.

Tank liners of all sizes and shapes, with wall thicknesses up to 1 in., are fabricated at the company's Maple Heights, Ohio plant, or on the site of final installation, depending on the complexity and size of the particular liner.



Portable Pocket Hardness Tester

Pacific Transducer Corp., 11921 West Pico Blvd., Los Angeles 64, is currently offering to industry a low cost portable pocket hardness tester for determining the hardness of steel alloys and other metals in the range of from 25 to 65 Rockwell C.

The test set features portability. It can be carried in the pocket on the job and can be used to test specimens of steel alloy in almost any place or position. It is a direct reading device. No further calculations are said to be necessary.

The test includes a microball indentor, a measuring microscope, and a standard hardness test block. It operates by means of an impact indentor which drives a

Full X-Ray Flexibility

assured for all-purpose inspection

Westinghouse 250 KV
JIB CRANE
X-RAY UNIT

Curtiss-Wright uses Westinghouse X-ray equipment for non-destructive testing of the important parts of their outstanding aircraft engines. The application pictured here shows the 250 KV X-ray tubehead, mounted on the jib crane tubestand, being positioned for the examination of the critical welds on gas turbine booster rotors.

The keynote for the selection of this equipment was *flexibility*—since *flexibility* results in more radiographs per shift.

1 Since the kilovoltage can be varied from 30-250 KV with greater X-ray output per KV resulting from the constant potential high voltage supply, the unit can be used to inspect materials from under ⅛" aluminum to 4" of steel.

2 The jib crane tubestand carries the tubehead from less than 3′ up to 9′ above the floor and from 50" to 141½′ from the center of the vertical column which, in turn, can be rotated 135° in each direction. The tubehead mounting permits rotation of 180°, in either direction, around a vertical axis, and 140° around the long axis of the tubehead. The X-ray tube can be positioned easily and quickly to radiograph parts ranging in size from very small to very large.

Call your Westinghouse representative, or write to Westinghouse Electric Corporation, Industrial X-ray Section, 2519 Wilkens Avenue, Baltimore 3, Maryland.

J-08263

YOU CAN BE SURE...IF IT'S

Westinghouse

INDUSTRIAL X-RAY

Now Stackpole can solder carbon brushes, contacts or friction devices directly to their metal supports!

Carbon brushes, for instance, can be silver soldered to leaf springs, thus eliminating brush holders and shunts. Carbon contacts can be soldered directly to metal arms. Carbon friction discs can be soldered directly to metal backing plates—and so on through an interesting range of possibilities. You gain all of the advantages of carbon—*without the need for costly fixtures for bolting or clamping it in place!* There are some limitations on size. Send details of your application for recommendation by Stackpole engineers.

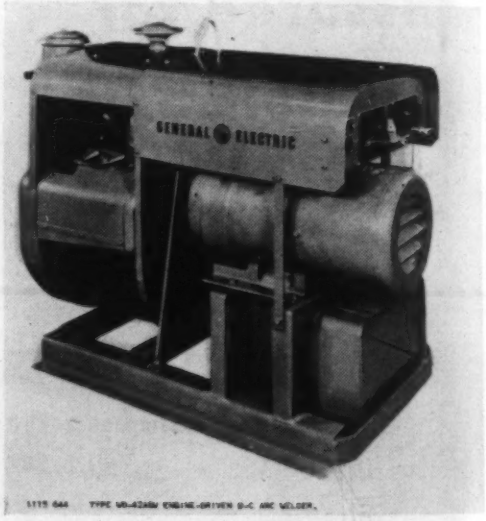
STACKPOLE CARBON COMPANY, St. Marys, Pa.

STACKPOLE
Everything in Carbon but Diamonds

New Materials and Equipment

1/16-in. tungsten carbide ball a short distance into the sample to be tested. The diameter of the indentation is then measured by the reticulated microscope. As the diameter is a function of the hardness, the reticle indicates the hardness directly. It is accurate $\pm 1\frac{1}{2}$ points C scale.

The new unit is said to be particularly adapted for testing all parts of large dies, punches and large welds as well as for structural steel, tanks and large pipes in position where only a portable tester of this type can be used.



New D.C. Arc Welder

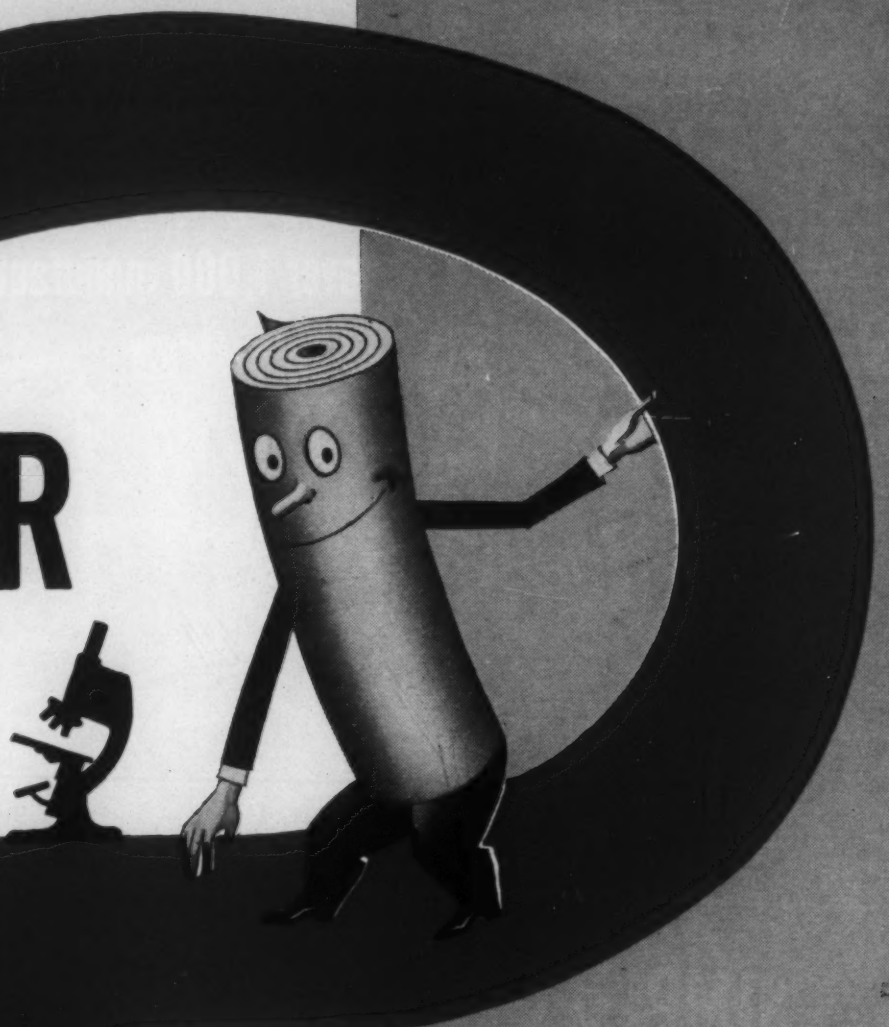
A new 200-amp, engine-driven d.c. arc welder with a 60% duty cycle has been announced by the Welding Dept., *General Electric Co.*, Schenectady 5, N. Y. Designated as type WD-42AGW, the new welder has a current range of 40 to 250 amp, and can be used with a variety of electrode sizes for repair, maintenance and construction work.

Consisting basically of a G-E type WD42 generator and a Wisconsin air-cooled engine, it is designed to fit crosswise in a standard pick-up truck. Optional equipment includes a trailer equipped with fittings for pressure lubrication.

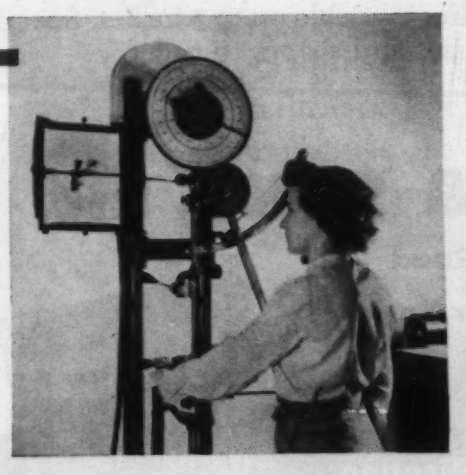
Forced ventilation is said to keep internal temperature within safety limits when the welder is operated on a 60% duty cycle at rated load. In addition, tests indicate that heavy overloads for short periods do not produce harmful effects.

Maintenance-wise, either the generator or engine can be removed easily for over-

WHAT'S YOUR INDUSTRIAL FABRIC PROBLEM



Need some expert advice on the right fabric for your special needs? Want a new fabric developed for a particular purpose — or an existing fabric adapted to a new application? We believe you'll find Mt. Vernon-Woodberry has the skill and experience it takes to work it out. Can we help?



Determining yarn tensile strength with 300-lb. vertical test. One of a series of comprehensive laboratory controls throughout production to assure uniformity in all Mt. Vernon-Woodberry products.

STANDARD FABRICS

Wide, Sail and Army Duck
Double and Single Filling
Hose-Belting and Shoe Duck
Filter Cloths
Dryer Felts
Narrow and Wide Drills
Twills

AT YOUR SERVICE

Mt. Vernon-Woodberry Mills' staff of textile engineers is available on request to help you with your problems in development or application of industrial fabrics.

FABRICS BUILT TO SPECIFICATIONS

For Calendering, Laminating and Other Industrial Applications

TURNER HALSEY
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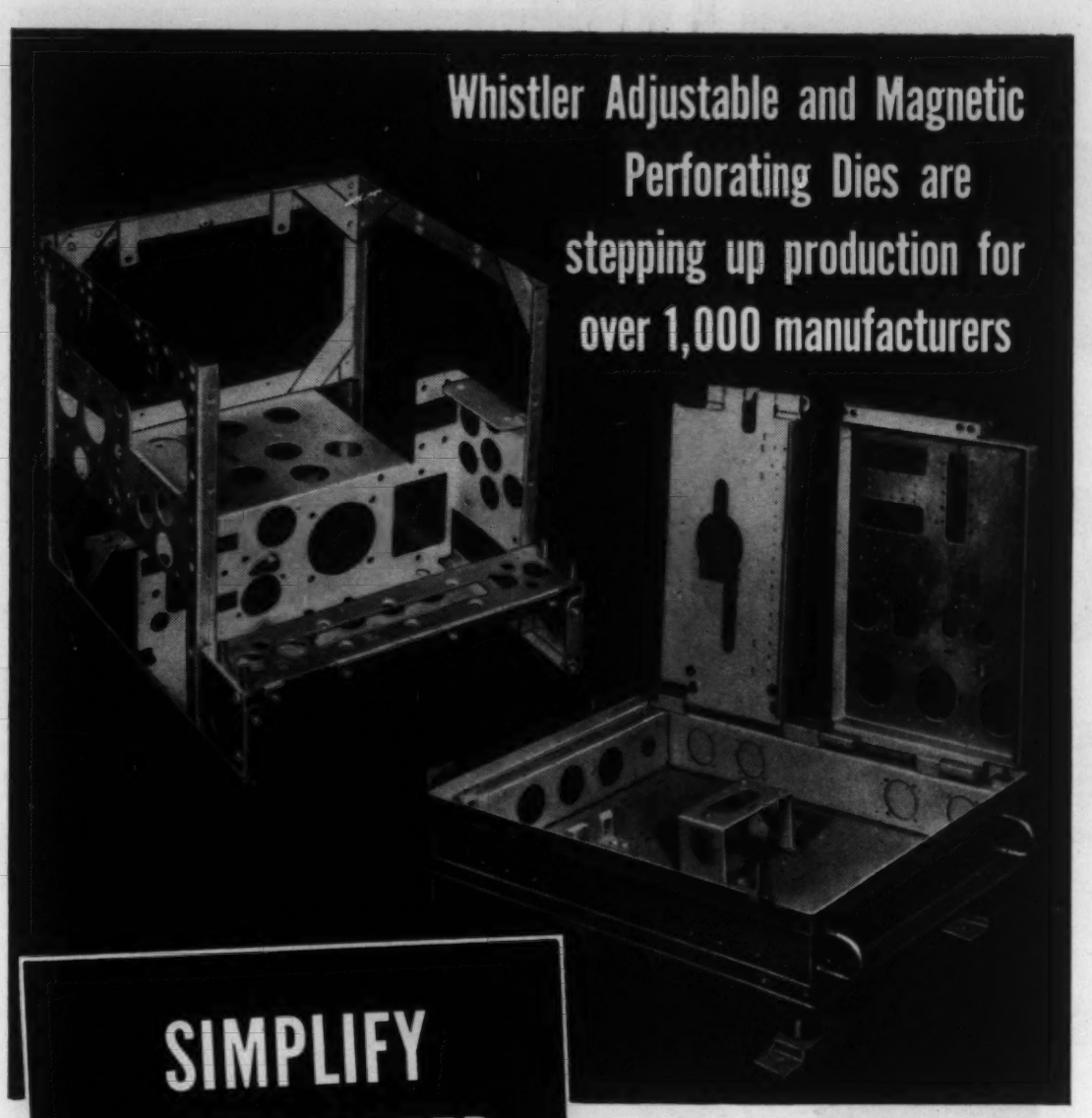


USE WHISTLER Adjustable and Magnetic Dies for perforating, notching and slotting sheet metals ... fast, accurate and cost cutting. Complicated patterns can be set up quickly. Hole arrangements can be changed in the press...without waiting and at no extra cost. New HU-50 units, that pierce at 90° angle, can be used in conjunction with standard perforating equipment. Fewer press operations are necessary.

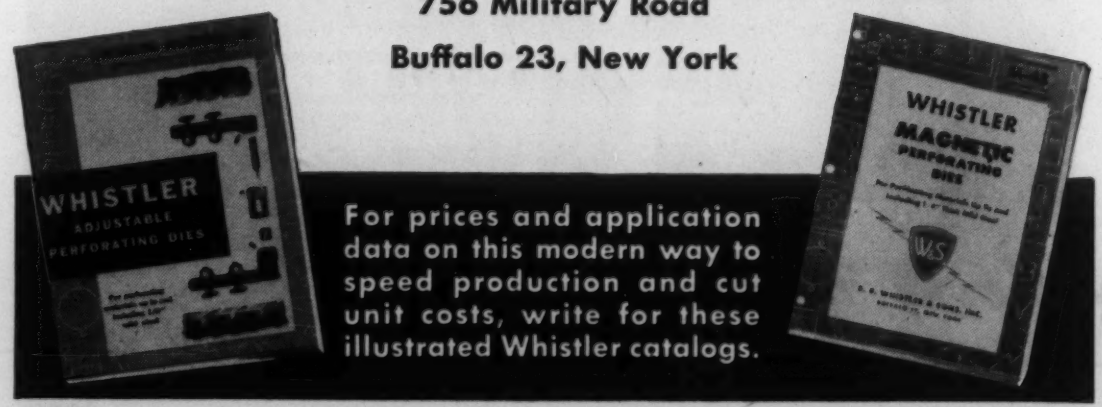
Re-use the same dies in different arrangements on many jobs. Punches and dies are interchangeable.

Whistler Adjustable Dies can be used in practically every type press. Standard sizes and shapes of punches and dies available up to 3 inches. Special sizes and shapes to order.

S. B. WHISTLER & SONS, Inc.

756 Military Road

Buffalo 23, New York



For prices and application data on this modern way to speed production and cut unit costs, write for these illustrated Whistler catalogs.

New Materials and Equipment

haul, and replaced by a standby unit. Since the engine is air cooled, coolants or anti-freezes are not required. A vacuum-type device is said to save gasoline by idling the engine when welding is not being done.

Quick-Setting Thermoplastic Cement for Metals and Nonmetals

The Industrial Div., *American Consolidated Dental Products Co.*, P. O. Box 2015, Philadelphia 3, has announced the availability of F-88, a radically new, quick-setting thermoplastic cement for general use. Unlike all other materials used for similar purposes, F-88 is said to require no air for setting, to set completely hard, and to be ready for finishing in a fraction of the time required by other materials.

The new cement permits joining of metals, wood, plaster, porcelain, stone, concrete and glass. It is completely adaptable for such applications as gluing, bonding, filling and sealing. According to the company, it will not shrink, expand, crack or change shape.

Quick-setting features of the cement make it ideal for emergency applications. By the choice of available liquids, it is possible to permanently bond materials in as little as 5 min. For longer setting times, special liquids are furnished. For use, F-88 is prepared by mixing the powder and liquid to make a thick creamy mix. No clamps are necessary for general bonding since the adhesive sets rapidly.

The new product is available in a complete range of colors and in standard container kits up to 100 lb.

New Finish Offers Many Advantages

Development of a new type of hammer finish enamel, which is said to have complete uniformity of pattern, has been announced by *Monroe Sander Corp.*, Long Island City, N. Y. The new product, known as Sanco Hammer Finish, results from the development of new synthetic resins and eliminates many problems once faced by manufacturers of metal products.

According to the company, use of

New Materials and Equipment

previous hammer finishes usually resulted in areas where designs were not uniform or didn't appear at all. However, the new finish is claimed to insure complete uniformity of pattern. Because of ease of application, a sprayer can work faster and get more mileage out of the finish. This will result in considerable cost savings to the manufacturer.

The new finish, available in a wide variety of colors, bakes rapidly, has good adhesion properties, is chip and scratch resistant, and covers imperfections with one coat. It does not require any primers.

Applications include all types of metal products and various types of wall boards.

Automatic Heliweld Hardfacing Process Announced

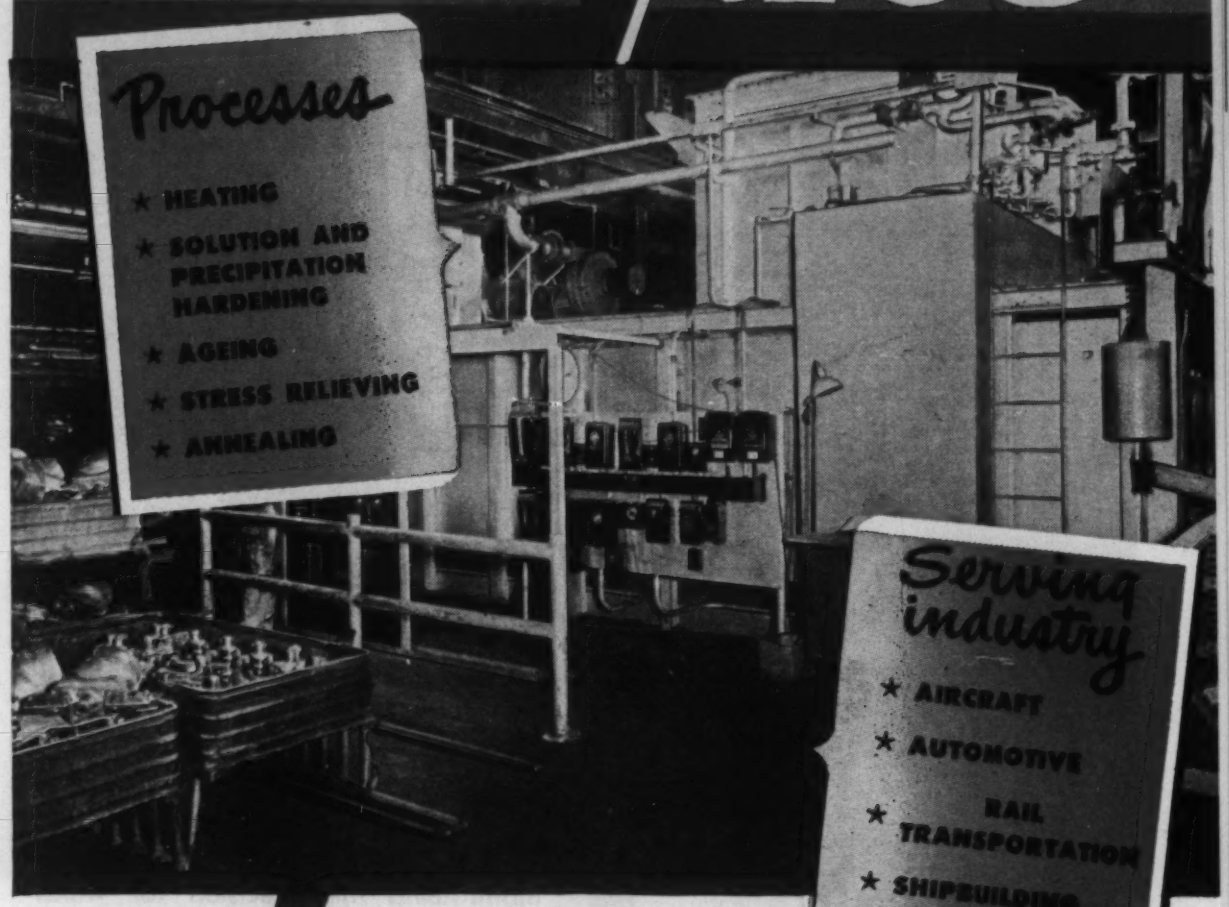
A new automatic hardfacing process, using the standard Automatic Heliweld Head and a unit for feeding bulk tungsten carbide, has been announced by *Air Reduction,* 60 E. 42nd St., New York 17.

Growing out of a need for improved methods in depositing tungsten carbide hardfacing material on tool joints for well drilling rigs, Airco has developed an automatic Heliweld hardfacing unit. Its flexibility is said to have been proved by numerous tests, which show that its use for the deposition of tungsten carbide hardfacing material is limited only by the ability to position the work and the arc in the proper relationship to each other.

The manner of deposition of loose, granular, pure tungsten carbide particles minimizes reduction of particle size by solution of the tungsten carbide into the base metal. It also minimizes the heat-affected area adjacent to the deposit.

In operation, the Heliweld arc melts

'Surface'



HEATING ALUMINUM cylinder head forgings at Tube Turns, Inc., Louisville, Ky. 'Surface' Combustion convection heated slat conveyor furnace operates at 900 F, producing 4600 lbs/hr net.

Gas-Fired furnaces for
heat treating aluminum

Why use 'Surface' furnaces?

Surface Combustion developed the forced convection type of furnace, which provides maximum temperature uniformity for heat treating aluminum. Also, convection overcomes the reflective properties of aluminum, heating the charge faster and more uniformly than other types of heating. Gas-fired salt bath furnaces for the heat treatment of aluminum and aluminum alloys are also available for special applications.

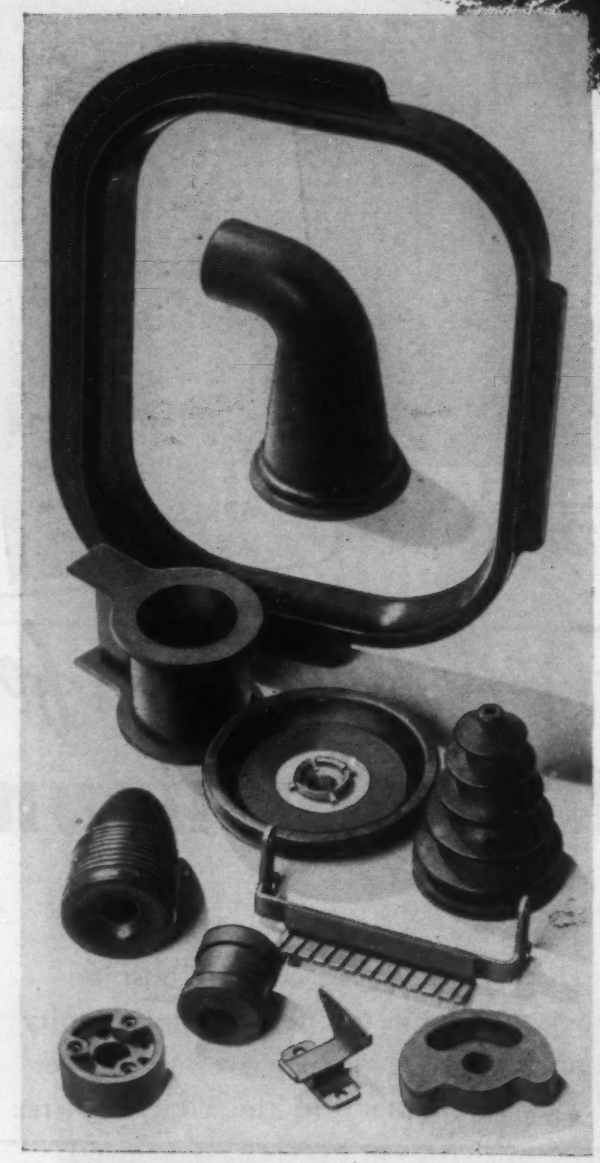
If you have unusual production requirements, odd-shaped parts, particular shop practices, or space limitations, there's a 'Surface' heat treat furnace to meet your requirements.

Write today.

SURFACE COMBUSTION *Corporation*
TOLEDO 1, OHIO

'Surface' INDUSTRIAL FURNACES AND BURNERS
Kathabar HUMIDITY CONDITIONING SYSTEMS
Janitrol AUTOMATIC HEATING EQUIPMENT

CONTROL
RAW MATERIALS
CONTROL
COMPOUNDING
CONTROL
MIXING
CONTROL
MOLDING
CONTROL
FINISHING



Visitors to ACUSHNET'S modern plant are particularly impressed by the scope and perfection of our Quality Control System. This rigid laboratory control at each stage of production is a positive safeguard in maintaining the precision for which Acushnet molded rubber parts are so widely known.

As precision starts at the expertly designed mold, control at this point is vitally important. Heats from all molds are sectionalized at least once a day and all essential dimensions of the product are measured. In addition, every two hours a full heat from every mold is checked, and certain basic dimensions selected for control purposes are checked. Particularly critical products are checked even more frequently and thoroughly.

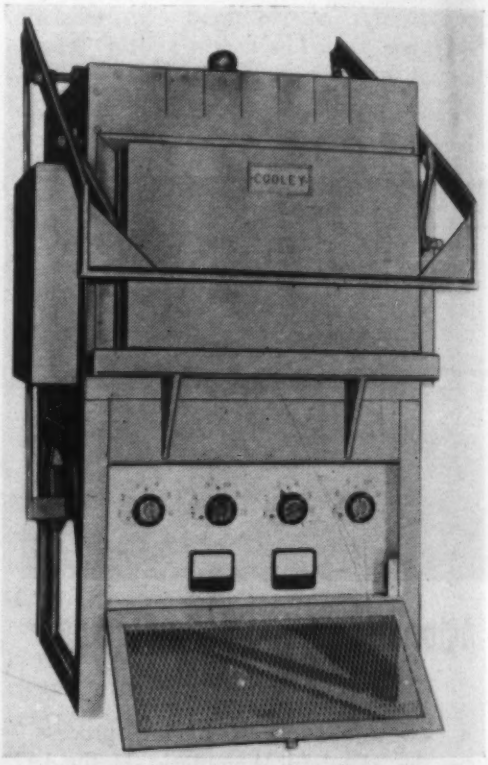
If your molded rubber parts call for controlled precision, you can call on ACUSHNET to meet your strictest specifications — to your complete satisfaction. Send for the "Acushnet Rubber Handbook", a comprehensive rubber data reference.

Acushnet
PROCESS COMPANY

Address all communications to 750 Belleville Ave., New Bedford, Mass.

New Materials and Equipment

the base metal, producing an elongated pool, and the tungsten carbide particles are poured into this pool behind the arc. The rate of tungsten carbide feed from the Vibratory Hopper mounted on the Heliweld head is electrically controlled with a high degree of accuracy. According to the company, tests have shown that the abrasion resistance of deposits made by this process is considerably greater than that attainable with other arc methods.

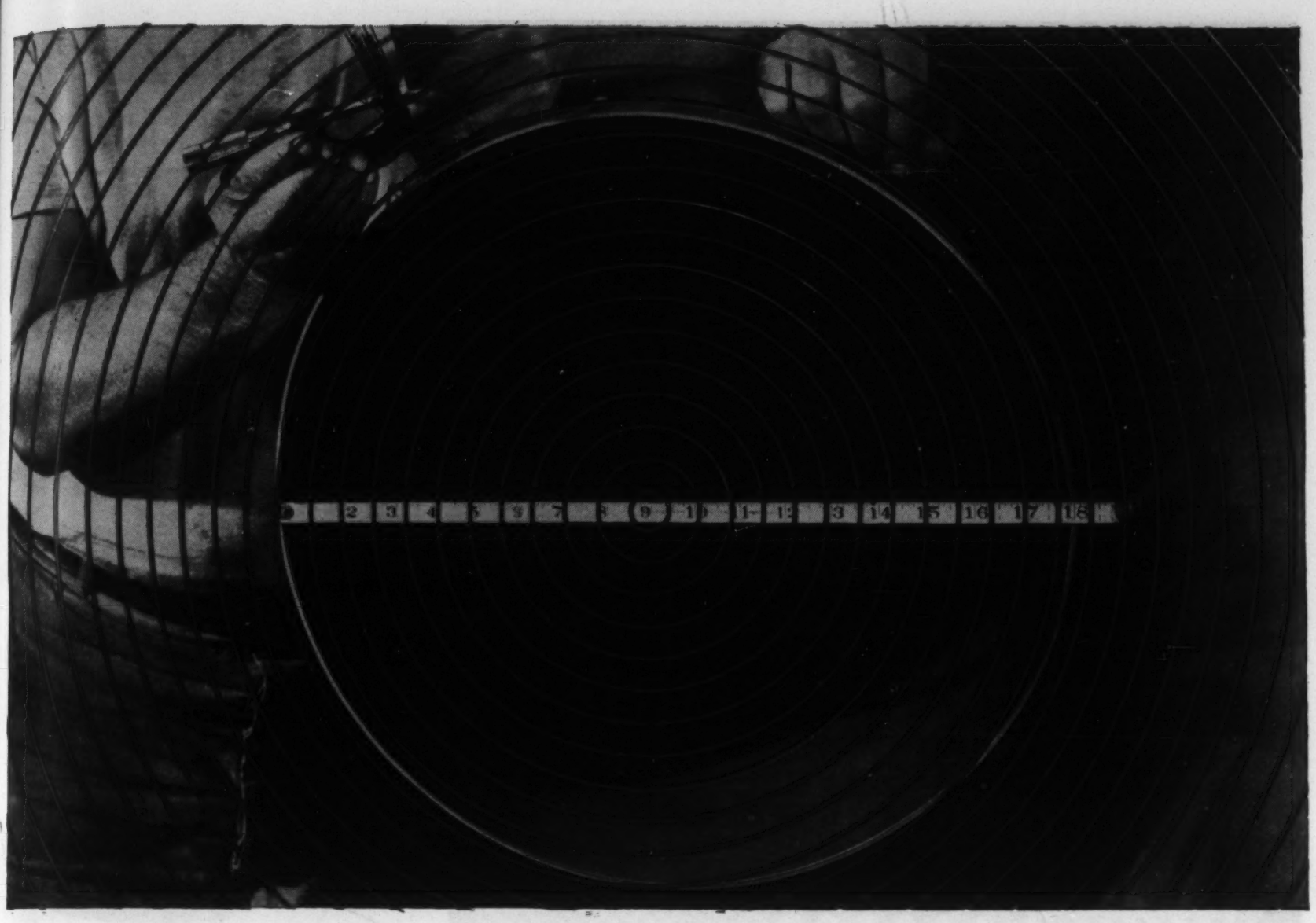


Hardening Furnaces for Tool Steels

Three models in a new line of electric high-speed tool steel hardening furnaces have been announced by *Cooley Electric Manufacturing Corp.*, 38 South Shelby St., Indianapolis 7, Ind. Operating temperatures cover the range of 1650 F to 2500 F.

Power control is accomplished by the use of multiple-tap transformers arranged for select voltages to be applied to the Globar heat elements located at the top and the bottom of the chamber. A novel feature of this design is the location and arrangement of the tap changing switches and ammeters which are placed at the front of the furnace for the convenience of the operator. Control of temperatures is handled by means of a standard pyrometer arrangement.

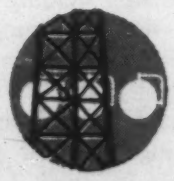
The furnace is heavily insulated by high temperature refractories, and it is said



from 1/8" *to* 40" **OD**

WHEN YOU NEED STAINLESS STEEL TUBING

TRENTWELD *will meet your needs best*



Name an industrial application that calls for stainless steel tubing — and the tubing to name is TRENTWELD. Available in diameters from 1/8" to 40" OD TRENTWELD presents a broad range of grades, gauges and finishes.

Study the product and the plant where it is produced and you find the reason for the steady increase in TRENTWELD usage. For TRENTWELD is made in a *tube* mill by *tube* experts who roll and weld stainless and high alloy tubing without added rod metal. This Trent method results in metallurgically correct tubing with a uniform section and uniform corrosion resistance.

No matter how specialized your tubing needs may be, you will find there's a TRENTWELD tubing to meet your most exacting requirements. To call in Trent is to put our experience at your disposal. Write us full details of your most pressing problem involving stainless or high alloy tubing.

TRENTWELD

STAINLESS STEEL TUBING

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of CRUCIBLE STEEL COMPANY OF AMERICA)

...Highlight your product appeal

These new low cost Velvaglaze Finishes capture the gleaming brightness that highlights product appeal. They offer greater surface durability and resistance to scratching, discoloration and stain.

Many unusual finish designs are available through Monarch's exclusive Velvaglaze Process. These designs cut casting costs by eliminating multiple finishing operations. They reduce rejects now encountered on highly polished, easy to mar surfaces.

Velvaglaze Finishes offer you an additional bonus when you specify Monarch aluminum Permanent Mold Castings and aluminum Diecastings. Consult with a Monarch engineer on all of your casting and finishing requirements. He will give you complete information on the specific Monarch service that meets your individual need.

*T. M. Reg. U. S. Pat. Off.

Monarch ALUMINUM MFG. COMPANY

- Aluminum Permanent Mold
- Aluminum Die Castings
- Certified Zinc Die Castings
- Complete Product Assembly
- Every Modern Finishing Service

Detroit Ave. at W. 93rd St., Cleveland 2, Ohio

New Materials and Equipment

to have an unusually efficient front door. Its size and thickness make it virtually a moving front wall, which gives unusual thermal efficiency and results in high economy from reduced door losses.

The following chamber sizes are available: 6¼ in. wide by 4 in. high by 9 in. long; 12 in. wide by 8 in. high by 18 in. long; 12 in. wide by 8 in. high by 24 in. long.

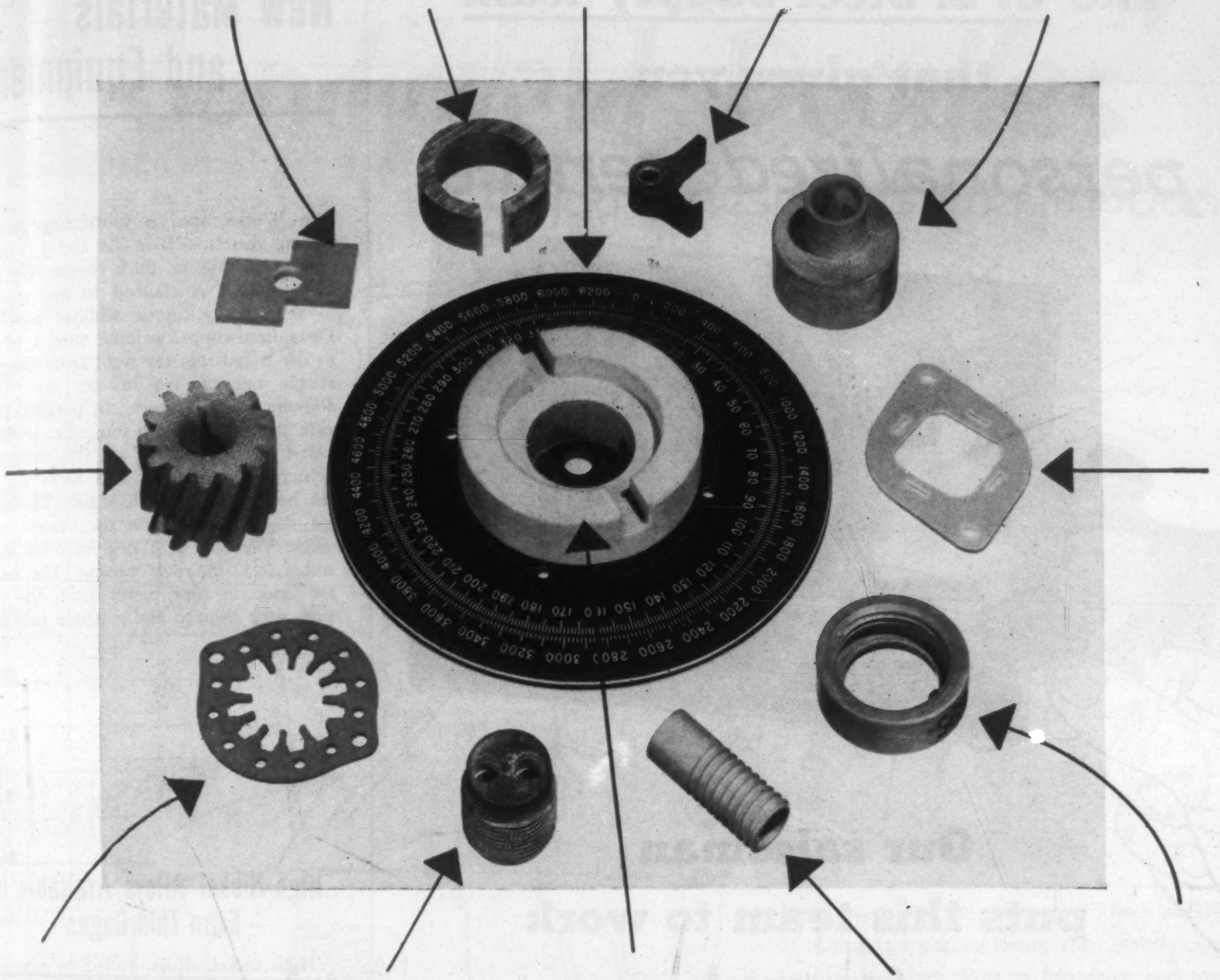
New Development in Inert-Gas-Shielded Metal-Arc Welding

The new model No. 20 Aircomatic Gun, the latest development for inert-gas-shielded metal-arc welding, has been announced by *Air Reduction*, 60 E. 42nd St., New York 17. This manual gun, designed to operate with currents up to 500 amp, is recommended for welding copper, bronze, stainless steel, nickel and steel.

The use of internal water cooling of the gun and a water-cooled welding cable permit high current capacity without sacrificing lightness and flexibility of the gun.

Rapid expansion of the use of Aircomatic welding has been due, in part, to the high production speeds available with the Aircomatic Head. For example, The J. S. Thorn Co., fabricators of aluminum window frames and sash, is using the unit to weld 15-ft seams in 3/16-in. thick 61S-T6 aluminum at 100 in. per min. The 3/32-in. dia 43S filler wire is supplied from a mechanical wire feed unit. No flux is required because of the protection afforded by the helium shielding gas employed. The Aircomatic Head is run on a standard track that is accurately aligned with the seam, and the operator has only to start and stop the equipment at the beginning and end of each seam.

Another company, Ansonia Copper and



solving a variety of problems in many industries

Lamicoid®

Today, more and more manufacturers whose products call for specific properties are solving their problems with LAMICOID... a thermosetting plastic laminate. Because LAMICOID utilizes fillers of glass, nylon, fabric or paper with various synthetic resins, this versatile material can be produced with just the property or combination of properties you need.

LAMICOID is also serving another purpose. In many instances its use conserves critical materials, and leads to product improvement and lowered costs.

Can you use a material which is easily machined or punched, tough and rigid, light weight, corrosion resistant, with high impact strength, low moisture absorption, and high heat resistance?

If you can, investigate LAMICOID. It is supplied in standard sheets, rods and tubes, or fabricated into parts of your specification. Our 58 years of experience in developing and producing electrical insulation is at your service. Write today for complete details or send blueprints and specifications for a prompt quotation.

MICO ELECTRICAL INSULATION

MICA *Insulator* COMPANY

Schenectady 1, New York

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LAMICOID (Laminated Plastic) • MICANITE® (Built-up Mica) • EMPIRE (Varnished Fabrics and Paper) • FABRICATED MICA

The U. S. Steel Supply team

that gives you

personalized service

Our salesman puts this team to work for you!

SUPPLYING your steel requirements becomes our team objective when you tell your needs to your U. S. Steel Supply salesman. Behind your salesman is a team of technical experts, each one a specialist in his field . . . and your business receives the attention of every member of the team who can contribute to its progress.

What do you need? Steel? Tools? Special purpose equipment or machinery? Advice on working an unfamiliar type of steel? Help in meeting a pressing delivery date? Give your order to your U. S. Steel Supply salesman. He will see that it gets immediate attention from the U. S. Steel Supply specialists best qualified to serve you.

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SAN FRANCISCO · SEATTLE
Sales Offices: INDIANAPOLIS · KANSAS CITY, MO. · PHILADELPHIA · PHOENIX
ROCKFORD, ILL. · SALT LAKE CITY · SOUTH BEND · TOLEDO · TULSA · YOUNGSTOWN

USS

UNITED STATES STEEL

New Materials and Equipment

Iron Works, Inc., is fabricating acetate mixing vessels, 6 ft in dia and 3 ft deep from 1- to 1⅛-in. thick copper. For the first time, it is claimed to be possible to weld heavy copper without pre-heat. Deoxidized copper welding wire, 1/16 in. in dia is fed into the weld from the gun at the rate of 396 in. per min. Two 400-amp Airco Hornets, in parallel, provide the required 470-amp, d.c. reversed polarity. The shielding gas is a combined helium-argon mixture. Gas flows are 50 cfh helium and 20 cfh argon. The joint for the girth weld on the vessels is a single Vee with a 90-deg included angle and a 3/32-in. root opening. The welds are made in four passes from the face side, back chipped and a single root pass made.

High Nickel Alloys Available in Extra Thin Gages

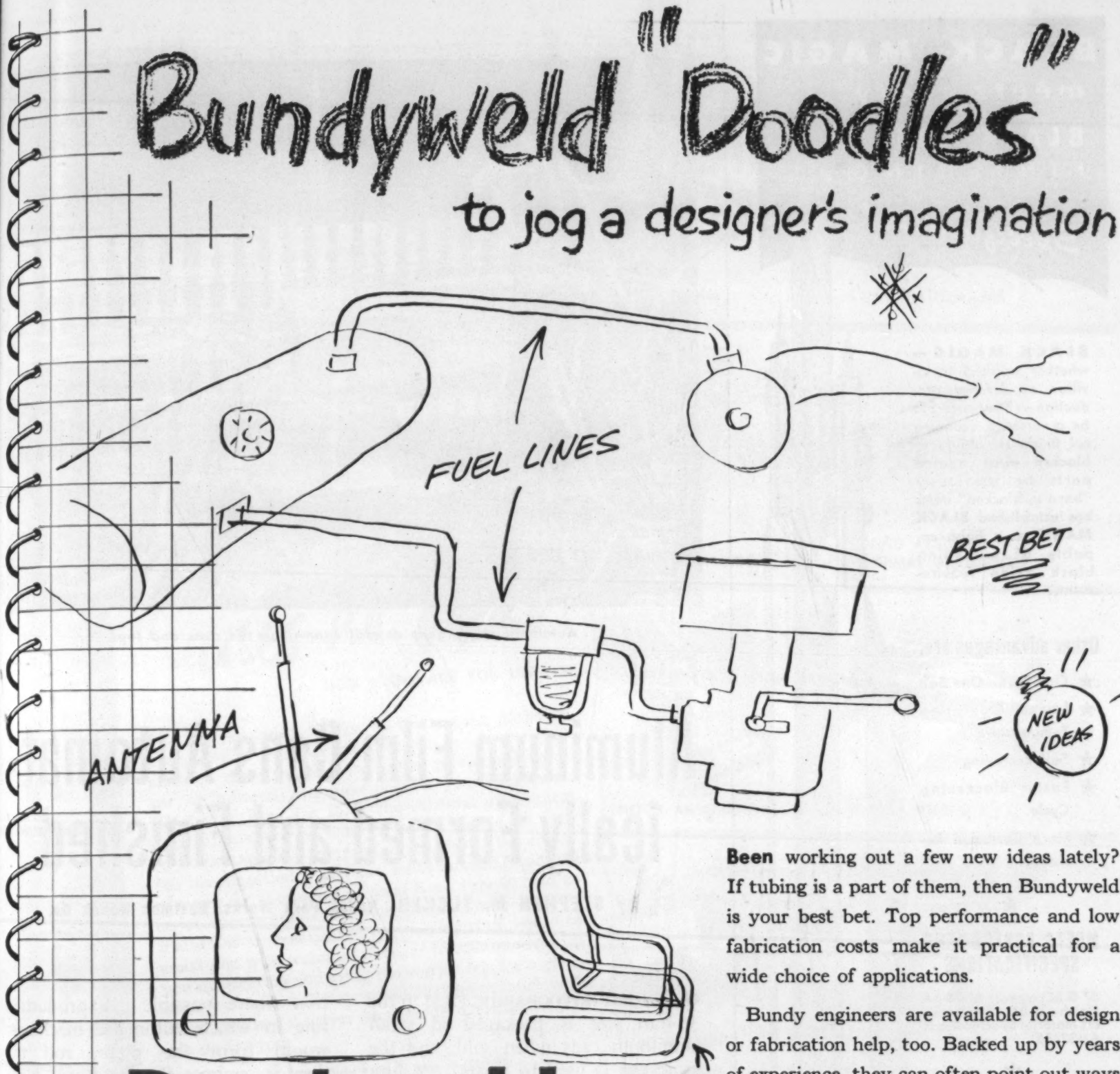
High nickel alloys, rolled to precision tolerances and ultra thin gages for use throughout industry, are now available from the Industrial Div., *American Silver Co., Inc.*, 36-07 Prince St., Flushing 54, N. Y. These metals (which include temperature compensation, low expansion, high permeability, glass sealing, and electrical resistor alloys) are now rolled to specifications by this company in strip up to 8 in. wide and down to 0.0005 in. thin—to tolerances as close as ±0.0001 in. The strip is available in any quantity from one to thousands of pounds.

This service was developed by the company to solve manufacturers' problems of obtaining high-precision and ultra thin high nickel alloy strip in development-laboratory quantities or high-production runs. The alloys processed at the company include: nickel-iron, nickel-chromium, nickel-cobalt-iron, and nickel-molybdenum-iron. The ultra thin, high precision metal strip is produced on precision 2-High, 4-High and Sendzimir rolling mills; on precision gang slitters; and through continuous atmosphere annealing lines.

Typical uses for these alloys include: speedometers in the automotive industry; navigation instruments in the aviation and marine industries; telemetering devices in the electric light and power industry; thermoswitches in the electrical industry; lead-in bushings in the electronics industry; magnetic shields in the instrumentation industry; dynamic balancing machines in the machinery industry; etc.

Bundyweld "Doodles"

to jog a designer's imagination



Been working out a few new ideas lately? If tubing is a part of them, then Bundyweld is your best bet. Top performance and low fabrication costs make it practical for a wide choice of applications.

Bundy engineers are available for design or fabrication help, too. Backed up by years of experience, they can often point out ways to save you time, material and money. Write for a catalog today.

Bundy Tubing Company, Detroit 14, Michigan.

WRITE

Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting strength
High endurance limit
Extra-strong
Shock-resistant
Ductile
Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform O.D., I.D.

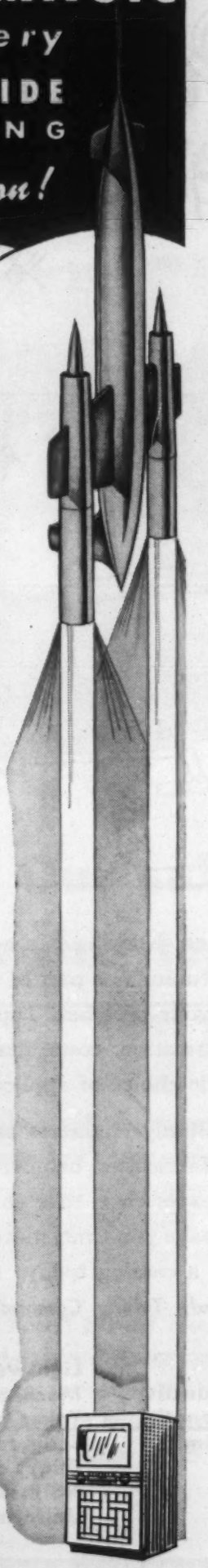
WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge, 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

BLACK MAGIC
meets every
BLACK OXIDE
FINISHING
Specification!



BLACK MAGIC — whether applied to civilian or defense production — has proved to be a versatile, economical finish. Its ability to blacken heat treated parts or previously "hard to blacken" items has established **BLACK MAGIC** as a finish capable of exceeding black oxide requirements.

Other advantages are:

★ One Bath—One Salt
★ Lower Operating Temperature
★ Self Rectifying
★ Faster Blackening Cycle
★ More Corrosion Resistant

★

MEETS GOVERNMENT SPECIFICATIONS

57-0-2C type 3; 51-70-1A Finish 22.04; Aeronautical Material Specifications AMS2485

★

A comprehensive study of the application of a black oxide finish has been compiled and is now available in our latest catalog. Write for your complimentary copy today.

Mitchell-Bradford

MITCHELL-BRADFORD CHEMICAL CO.
2446A MAIN ST.
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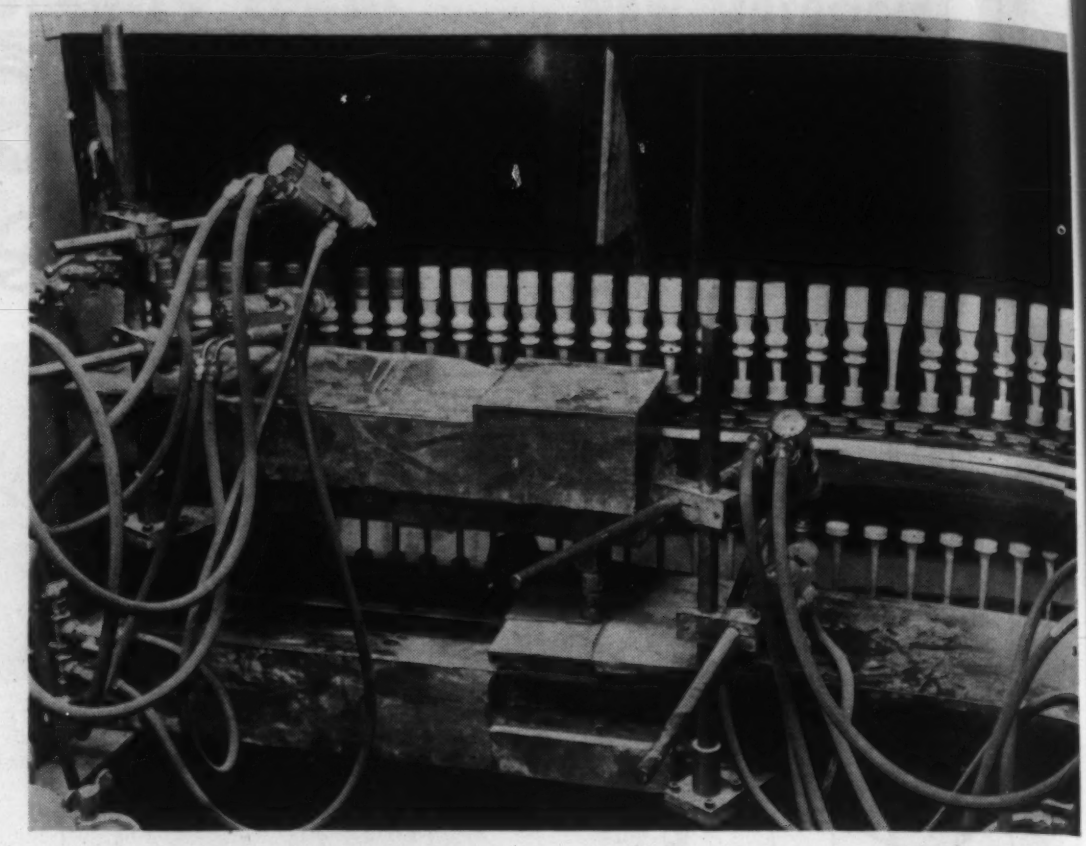
QUALITY PRODUCTS OF CHEMICAL RESEARCH



Automatic spray guns deposit enamel on the cans and tops.

Aluminum Film Cans Automatically Formed and Finished

by STEPHEN M. TUCKER, Kodak Park Works, Eastman Kodak Co.

● COLOR PHOTOGRAPHIC FILM in the 35-mm size is packaged in small aluminum cans when sold, and the same can is used to protect the film when the retail purchaser mails it back to a processing laboratory after exposure. Aluminum is an ideal material for the cans because of its light weight and imperviousness to water and water vapor, and also because of the ease with which it is formed.

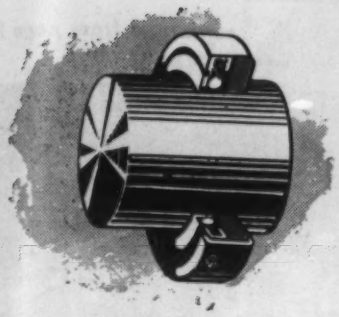
Formerly, the cans were formed from annealed aluminum strip of the proper weight, threads were rolled on can and lid, the company name was embossed on the side of the can, a rubber gasket was placed in the lid, and the can was painted with an identifying color, the color indicating what type of film was enclosed. There was considerable hand work in the handling of the pieces in process, and in transporting the work from operation to operation. The production line required 15 men, even with a certain amount of conveyorizing.

It was felt that the process might be studied with a view to cost reduction where possible. A production line in which automatic machinery would form the piece, roll the threads, emboss the lettering, place the gasket, and paint the can, while conveyors transported the workpieces from strip stock to finished can, was the goal. This was accomplished to all practical purposes.

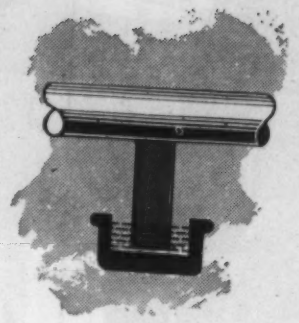
A study of the materials used offered a chance for a cost reduction in only one instance. The rubber gasket placed in the lid to form a tight seal over the can was somewhat expensive as a material, and it caused difficulties in handling and use that were an additional source of expense. After testing, it was decided to use an extruded plastics elastomer that could be formed in position, and would bond itself to the can lid so that there would be no difficulty in handling. The aluminum itself was annealed commercially pure aluminum, 2SO, and gave satisfactory performance.

The present process begins with annealed aluminum strips 0.015 in.

(Continued on page 170)

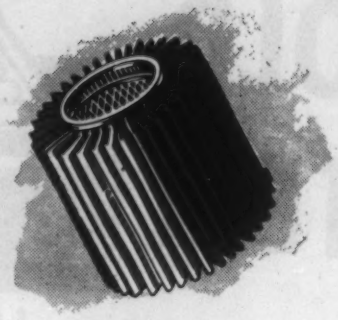


SEALING



WICKING

POLISHING



FILTRATION – AIR

HERE ARE

16

OF THE CARDINAL

uses for FELT

HOW MANY ARE YOU USING?

FELT does many things, so many that probably every day of your life it serves you in some way or another, directly, as in the grease retainers in your car, or indirectly, to make possible your eyeglasses. Illustrated here are 16 of the cardinal mechanical applications, one or more of which should be used to advantage in your product or plant. We invite full investigation. American Felts include hundreds of types for thousands of uses. Each type is held to strict specifications and standards. American Felt maintains an experienced engineering staff, ready to assist you with technical data, or to collaborate with you in selecting and using the correct felt for a given application. Samples are available. Get in touch with American, and discover what modern felt techniques can do for you.

American Felt Company

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GENERAL OFFICES: 24 GLENVILLE ROAD, GLENVILLE, CONN.
SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, San Diego, Montreal. — PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.— ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

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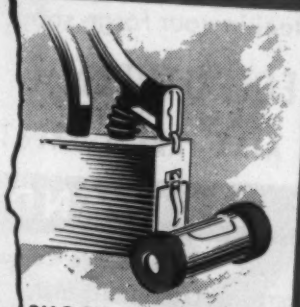
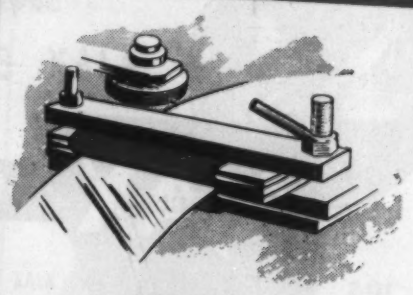
FILTRATION—FLUIDS

SOUND ABSORPTION & THERMAL INSULATION

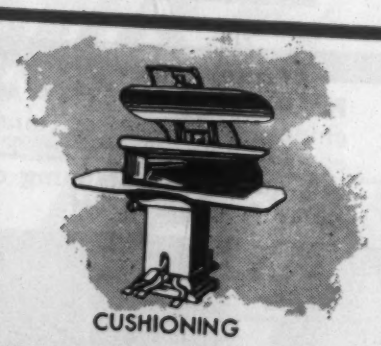


SHOCK ABSORPTION



WIPING

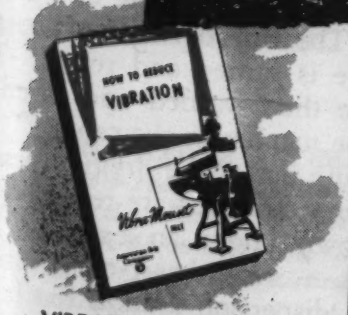
MOISTENING



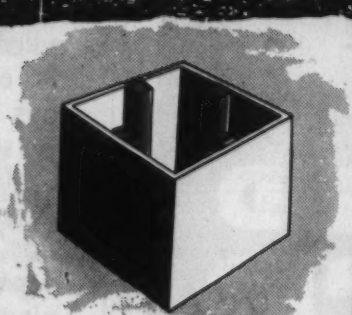
CUSHIONING

PADDING

PERCUSSION

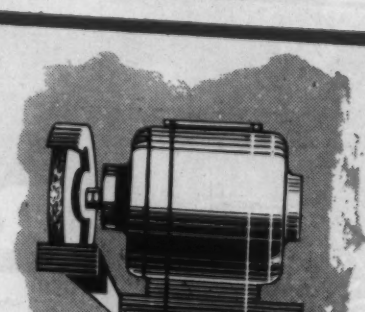


VIBRATION CONTROL
SEND FOR BOOKLET



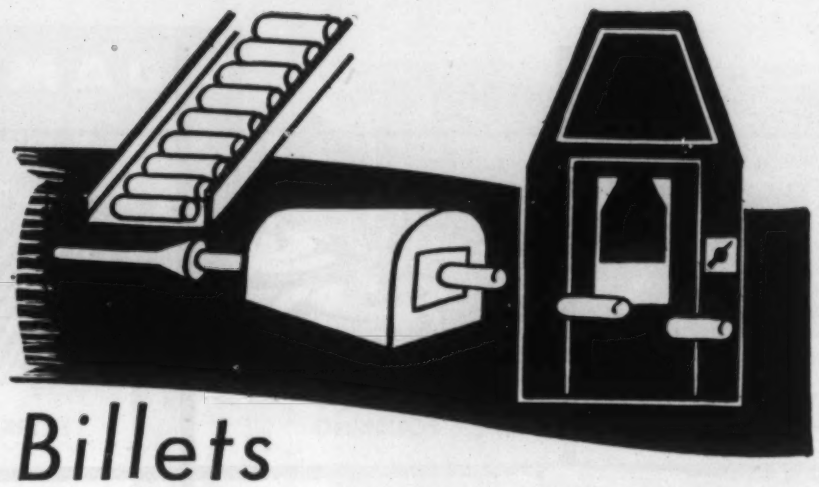
PACKAGING

SURFACING



FRICTIONAL

COLD STEEL



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...IN 39 SECONDS

Ajax-Northrup heaters work so fast there's no time for oxidation or decarburization . . . no time for scale to form.

RESULT: Steel savings up to 20% . . . ten tons a day for one Ajax-Northrup equipped automobile manufacturer.

Typical production: 720 perfect pieces per hour.

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141-S

FILLING AN ORDER BY AUTOMATIC SPINNING. Automatic machines, developed by Teiner, permit precision spinning to reduce costs on long-run items. Example of the all-gauge — all-metal — any-quantity — spinning capacity available at Teiner. ***Write for color Brochure 52 M.***

ROLAND TEINER CO. INC. METAL SPINNING

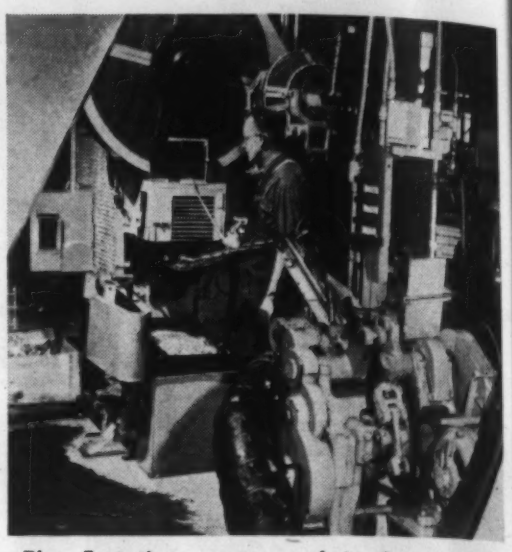
ROLAND TEINER

COMPANY, INCORPORATED

134 TREMONT ST., EVERETT 49, MASS. Tel. EV 7-7800

Aluminum Film Cans . . . .

continued from page 168



The 5-station press used in forming the film can. In the foreground is the machine which rolls the threads into the top of the can and presses trademark into the side.

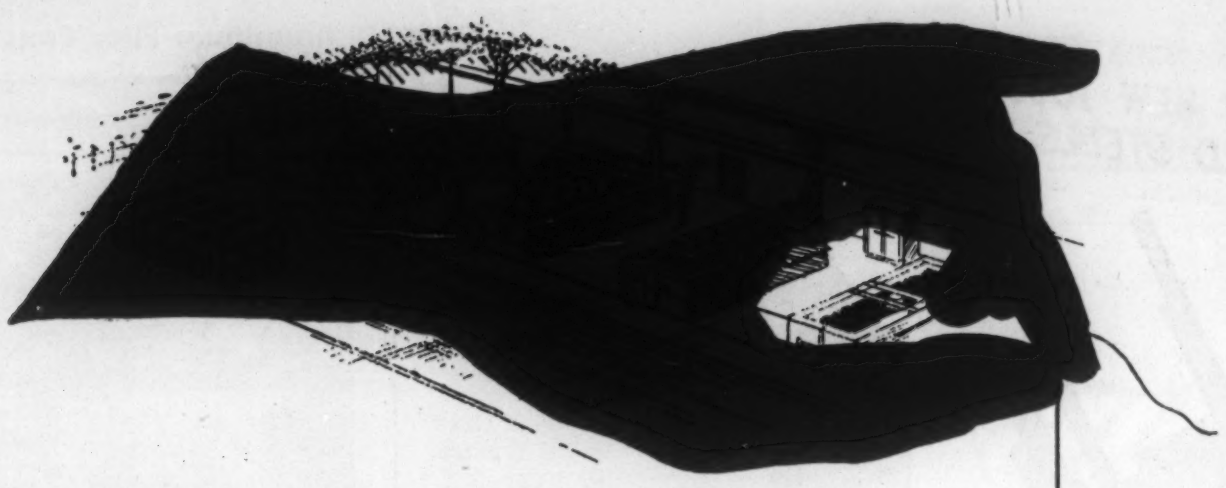
thick for the cans, and 0.012 in. thick for the tops. The strip for the cans is fed into a press using a five-station progressive die. The disc is blanked and cupped in the first station, and the three successive stations complete the draw to can form. The can is trimmed in the final station. All movement of the work, from feeding of the press to ejection of the finished can, is automatic. The press is equipped with automatic stops which halt operations if trouble develops.

At the discharge end of the press a conveyor chute carries the cans to the thread roller, where the threads are rolled into the top of the can. The company name is pressed into the side of the can by circular dies in the same machine, also. This completes the forming of the can, and the pieces are automatically conveyed to a rotary washer, which frees them from any grease or dirt, then dried in a hot air oven.

The can tops or lids are similarly formed on a small press that blanks them—two at a time—from 0.012-in. strip and cups them to finished form in one operation. The pieces are then conveyed by a chute to a thread roller. The thread is rolled in, and the edge is turned and rolled. The tops are then washed and dried in the same manner as the cans.

Moving out of the drying oven on a conveyor, the tops are revolved upside down under an extruder that deposits a small bead of a viscous plastics dispersion around the inside edge of the top, in the same position that a gasket would occupy. The conveyor then carries the pieces into

(Continued on page 172)



Replace the Atom!

Into the limbo of lost atoms go all aircraft cylinders, as their usable bore limits are reached. But why scrap them? Replace the lost atoms and the cylinders are new again!

That's the Van der Horst answer to wear. We use PORUS-KROME*, to put back atoms that last twice as long as the kind they replace.

For ten years in this way, the armed services have cut costs — and improved engine efficiency. Now, PORUS-KROME cylinders are standard in *new* aircraft engines, as well.

By replacing less-durable atoms at low cost, this Van der Horst chrome has solved many a critical wear problem. Have you one?

W52-2A

* *PORUS-KROME is a dense, hard, wear and corrosion-resistant chromium, produced by the Van der Horst Corporation of America, and which gives working surfaces an infinite number of tiny oil-retaining reservoirs for perfected lubrication.*

U. S. PATENTS 2,048,578, 2,314,604 and 2,412,698

VAN DER HORST

VAN DER HORST CORPORATION • OLEAN, N. Y.

How All Three Speed Steels Make Plastic Pipe More "Flexible"

Carlon is a plastic pipe used to transmit fluids and vapors over irregular surfaces. This Speed Steel Mold—using Holliday's Speed Case (X1515), Speed Treat (X1545) and Speed Alloy hot rolled alloy plate steel helps make Carlon even more "flexible". It molds 6" dia. threaded plastic couplings that join either long lengths of Carlon to Carlon or Carlon to standard metal pipe.

Naturally, these couplings have to be near-perfect to prevent leakage. Carlon Products Corp. reports top distortion-free production at the rate of one shot per minute. Houk Machine Company, Barberton, Ohio who made the mold of Speed Steels for Carlon, reports 40% faster machining than regular hot rolled carbon or tool steels plus an absence of warpage and distortion and longer tool life. Top and bottom plates are of ground Speed Treat plate, male and female core are of Speed Case carburized to Rockwell 55 "C" then ground to size. Other parts are of Speed Alloy.

How versatile Speed Steels are solving new fabricating problems every day makes mighty profitable listening. Check with your Speed Steel distributor or write direct for literature.

SPEED STEELS

SINCE 1856 W. J. HOLLIDAY & CO. (INC.)

SPEED ALLOY ■ SPEED CASE ■ SPEED TREAT

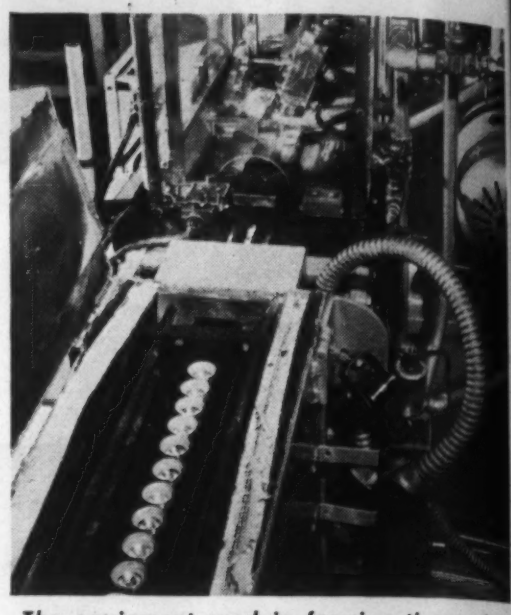
DISTRIBUTED BY

Brown-Wales Co., Boston-Hartford-Lewiston, Me. ■ Bridgeport Steel Co., Bridgeport, Conn. Beals, McCarthy & Rogers, Buffalo, N. Y. ■ Burger Iron Co., Akron, Ohio ■ Grammer, Dempsey & Hudson, Inc., Newark, N. J. ■ Earle M. Jorgensen Co., Los Angeles-Houston-Oakland-Dallas ■ Passaic County Steel Service, Inc., Paterson, N. J. ■ Peckover's Ltd., Halifax-Montreal-Toronto-Winnipeg-Vancouver ■ Peninsular Steel Co., Detroit, Mich. Pidgeon-Thomas Iron Co., Memphis, Tenn. ■ Horace T. Potts Co., Philadelphia-Baltimore

Produced by W. J. Holliday & Co., Inc., Speed Steel Plate Division, Hammond, Indiana. Plants: Hammond and Indianapolis, Indiana

Aluminum Film Cans . . . .

continued from page 170



The equipment used in forming the gasket on the can top. Gasket material is placed in the tops by the extruder in the background. Tops then move through oven (top removed to show details) in foreground.

a small tunnel oven. Here the temperature is maintained at 450 F, and the bead of plastics material softens and flattens out to form a narrow band of elastomer that serves as a gasket. The heat also sets up the dispersion so that it ceases to be a viscous liquid and becomes a rubbery solid. The band is attached to the aluminum top, so there is no danger of its being lost, or distorted, or otherwise being made ineffective while the can is in service.

Both cans and tops are now automatically positioned on revolving holders on a double chain conveyor and carried to the automatic painting machine. They are slowly revolving as they come to a position in front of the spray gun. Without stopping the conveyor, the spray gun is turned on automatically, spraying the pieces as they move in front of it, then turned off as the pieces pass on.

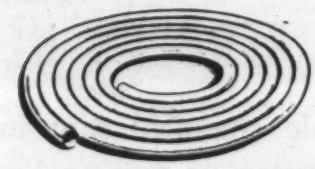
Continuing beyond the spraying machine, the conveyor carries the enameled cans and tops into a baking oven, held at 400 F. Travel time through the oven is 6 to 7 min. The final step on the conveyor is the spraying of the threaded portion of the enameled can with a wax solution to lubricate it. Finished cans and tops are then removed from the conveyor, ready for use in packaging film.

The production line formerly in use required 15 men to man it. The present line operates with only five men, and as soon as operations are smoothed out it can be run with four men.

For Brass and Copper Tubing that will LAST...

Think of H&H *First*

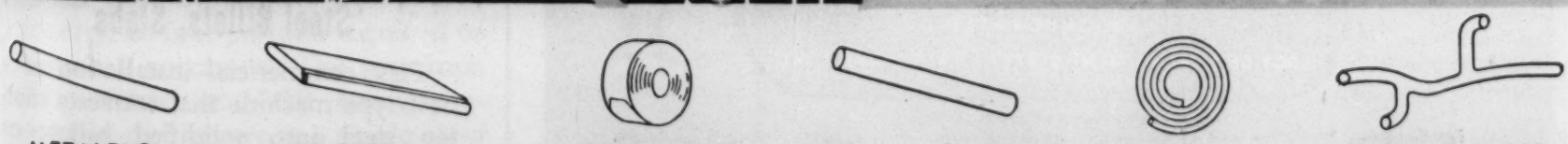
HELPING to heat the homes of America is still another vital function of H & H brass and copper tubing and fabricated parts. And like all tubing which H & H manufactures, the H & H COPPER OIL BURNER TUBE shown at the left can be depended upon for those challenging applications where quality and long life are essential. So whether you make oil burners, motors or machines; automotive, air conditioning or plumbing equipment . . . for brass and copper tubing that will *last*, see your nearby H & H representative *first*.



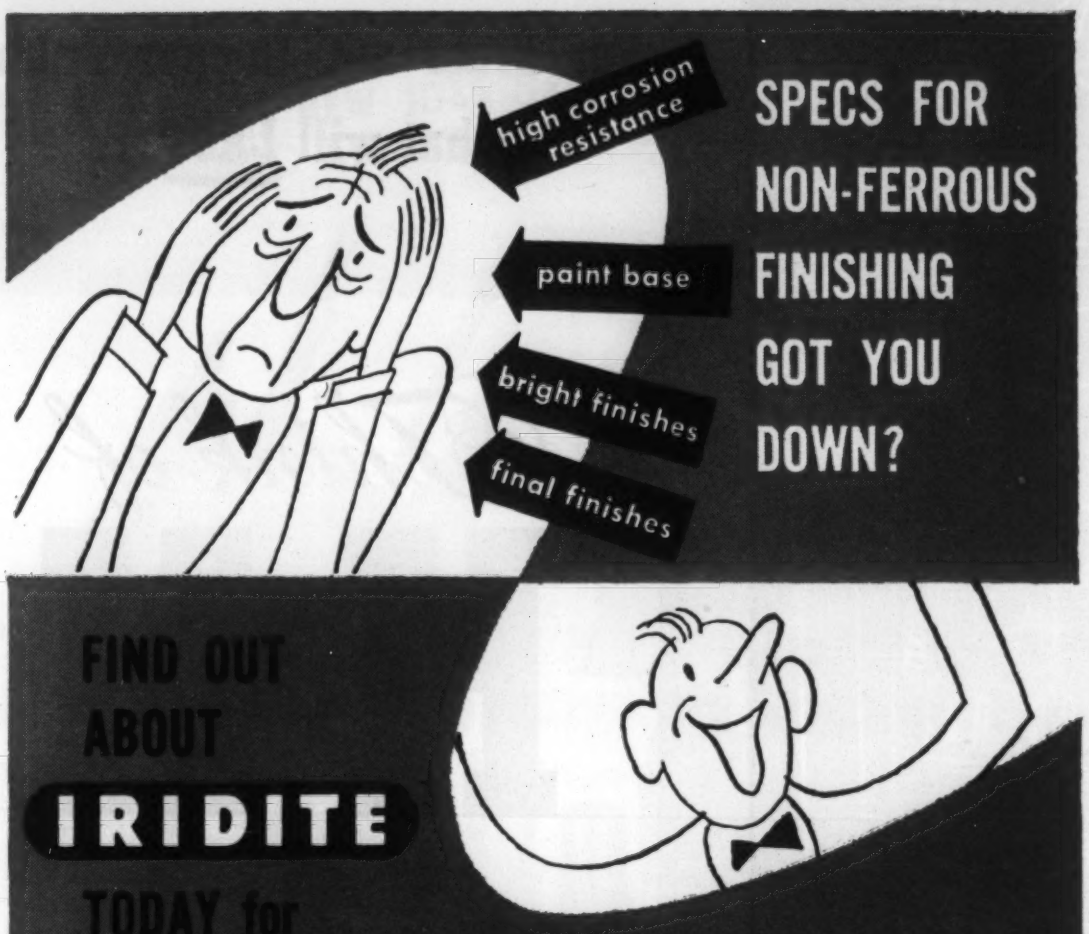
COPPER OIL BURNER TUBING

Bright Annealed • Uniform Temper For Easy Flaring and Handling • 50-Foot Coils
Available in 6 Sizes — ¼" thru ⅝" O.D.
.049" Wall Thickness • Carton or Bulk Packed

H&H TUBE AND MANUFACTURING COMPANY
252 North Forman Avenue, Detroit 17
Originators and sole makers of "Metalflo" — the economy tubing



METALFLO LOCKSEAM COIL STRIP AND SEAMLESS TUBING TUBULAR PARTS



News Digest

continued from page 13

mar more easily than do regular polystyrene products.

"It is apparent that the ASTM impact strength measurements alone cannot define the characteristics of these plastics materials. When all of the laboratory test values of a material are considered, an end user, designer, molder or extruder can determine the material best suited for a proposed application on a sound basis. Many failures could be prevented and large sums of money saved by using all of the facts and figures at hand.

"These modified polystyrenes have some very desirable properties, also some limitations. Indiscriminate use can be harmful. The following guiding principles may be of some aid in the proper use of these materials:

1. Use these materials for improved shock resistance in polystyrene type applications.
2. Use these materials for their acid and alkali resistance.
3. Use these materials on the basis of good dimensional stability with shock resistance.
4. Use these materials for their good electrical characteristics with shock resistance.
5. Use these materials on the basis of their properties and not their low cost alone.
6. Do not expect strength or durability of metals.
7. Do not disregard the need for slightly different molding and extrusion conditions and techniques.
8. Do not disregard the guidance available in a material suppliers data sheet.
9. Do not rely upon impact strength values alone on proposed applications."

New Machine to Continuously Cast Steel Billets, Slabs

First commericial installation of a new type machine that converts molten steel into solidified billets or slabs in a continuous line will be

JOHNSON **SLEEVE BEARING DATA**

Bearing DESIGN

BRONZE **SLEEVE BEARING DATA**

Standard Tests for Sleeve Bearings-2

As pointed out in the preceding data sheet—"Standard Tests-1"—the prime reason for the large number of tests employed is simply to assure the user that he is getting the greatest bearing performance possible for his money. This is necessary in Sleeve Bearings not only because there are so many types of bearings available but also because it is possible to so design any type to secure all the necessary properties. Cast bronze is a good example. There are approximately one hundred separate and distinct alloys from which to choose. If plasticity and/or embeddability is a chief requirement the usual method is to increase the lead content. If greater hardness is required, the lead content is lowered, then tin, or nickel, or manganese, for instance, is increased.

One of the chief points to remember in specifying sleeve bearings is that they can be "tailor-made" to suit practically any application. The only requirement is that we first determine all of the pertinent operating factors.

Johnson Bronze Alloy No.	PHYSICAL PROPERTIES			
	(1) Wear Rate (dry)	(2) Coefficient of Friction (dry)	(3) Izod Notch Toughness	(4) Resistance to Pounding
19	0.24	0.16	3.4	54
25	0.36	0.14	5.2	22
27	0.32	0.19	4.4	63
29	0.35	0.16	5.6	40
51	0.63	0.25	8.3	81
53	0.62	0.26	8.5	86
55	0.53	0.29	3.9	109
66	0.50	0.19	8.4	20
71	0.64	0.18	12.1	20
72	0.41	0.19	8.6	38

A typical listing and comparison of various popular, cast bronze bearing alloys.

Resistance to Fatigue

This is the ability of the bearing material to withstand shocks and loads without deterioration or fracture. It is particularly valuable in testing bearings for internal combustion engines with rapidly alternating stresses on bimetal bearings such as steel backed, babbitt or bronze lined.

Izod Notch Toughness

This determines the amount of energy in foot pounds required to break a specimen. The specimen is notched and the energy required to fracture in a single blow indicates the toughness.

Resistance to Wear

This test determines the physical ability to resist destruction of two surfaces rubbing together without lubrication. The results are usually tabulated in the loss of weight in grams per 10,000 revolutions.

Resistance to Pounding

This is determined by establishing the number of blows of a hammer weighing 7.5 pounds, falling 2 inches, are required to deform the specimen 5%.

Coefficient of Friction

This test in bearing material is always computed on a "dry" basis, or a set up in which no lubricant of any kind is used. It is usually determined on an Amsler wear test machine.

Thermal-Conductivity

Thermal-conductivity is the ability of a bearing or bearing material to dissipate heat. It is a determination of the B.T.U.'s, per unit of time that will move through the material.

•

Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

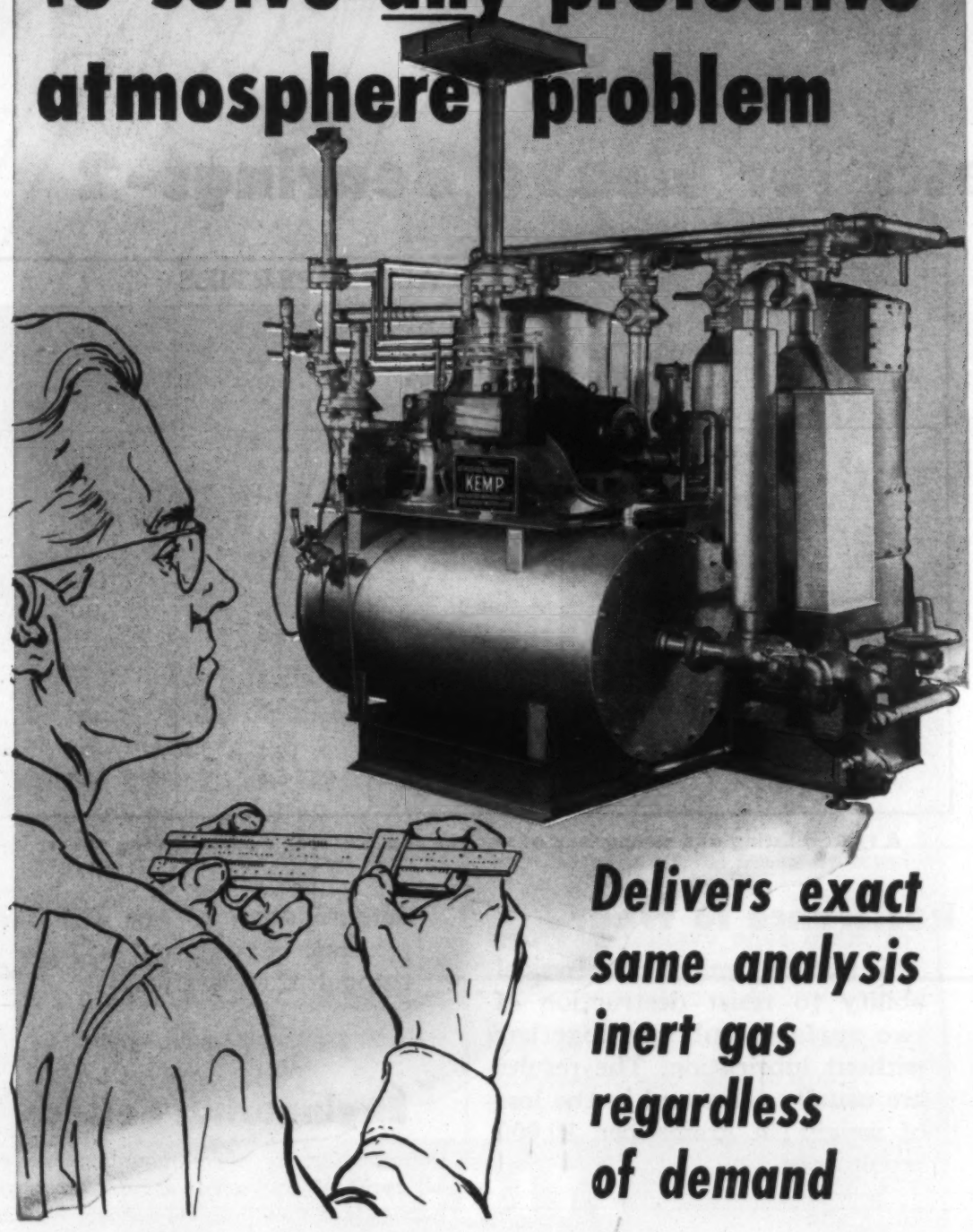
•

This bearing sheet data is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
769 S. MILL ST. • NEW CASTLE, PENNA.

You can count on KEMP to solve any protective atmosphere problem



Delivers exact same analysis inert gas regardless of demand

DAY AFTER DAY Kemp users throughout the metals field report: Kemp Atmosphere Gas Generators *maintain* exact analysis of chemically clean atmosphere gas *regardless* of demand . . . *eliminate* the possibility of mixture fluctuations at some critical phase of processing. These same users report big gas and maintenance savings with Kemp. Also Kemp Generators are fast-starting, easy-to-operate . . . offer real savings in both *time* and *money* by reducing the costly warm-up period necessary for starting. You can't go wrong when you specify Kemp Atmosphere Gas Generators.

Set it . . . forget it!

The Kemp Industrial Carburetor, standard equipment and the very heart of every Kemp installation, assures you complete combustion . . . without tinkering . . . without waste. Uses ordinary gas right from mains. Every Kemp Design includes complete up-to-the-minute fire checks and safety devices. Why not find out how Kemp can help you with your problems, today?

KEMP
OF BALTIMORE

GAS GENERATORS
Write for Bulletin I-10 for technical information
THE C. M. KEMP MFG. CO.
405 E. Oliver Street, Baltimore 2, Md.

CARBURETORS • BURNERS • FIRE CHECKS • ATMOSPHERE & INERT GAS GENERATORS
ADSORPTIVE DRYERS • METAL MELTING UNITS • SENSING EQUIPMENT • SPECIAL EQUIPMENT

News Digest

started at Welland, Ontario, within a few months.

Koppers Co., Inc. and Atlas Steels Ltd. of Welland have announced details of a contract by which Koppers will design and construct a continuous ferrous-metals casting machine to produce tool, stainless and other high grade steels. This revolutionary development will yield from 10 to 15% more finished steel per heat than conventional pouring methods.

With an uninterrupted supply of molten metal, the new machine would be capable of casting a continous billet or slab of indefinite length. In actual practice, automatically-moving acetylene torches will cut the metal into usable lengths as it emerges from the casting machine.

Continuous casting machines, particularly in small and medium-sized plants, will allow by-passing of the blooming mill and soaking pits in the steel-making operation with sizeable cost-savings.

These continuous casting machines have been used in the nonferrous industries for several years in this country and abroad. Junghans machines, upon which the original patents were based, are operating on steel and other metals in Germany. In 1949 a pilot machine for steel was erected at the Allegheny Ludlum Plant at Watervliet, N. Y., to resolve further problems presented in continuous casting of steel. Allegheny's exhaustive research was joined by the Freyn Engineering Dept. of Koppers Engineering and Construction Div., over a year ago when Koppers purchased the right from Continuous Metalcast Co., Inc. to design and build such machines under the Rossi-Junghans Patents. The Atlas installation will be the first embodying the new developments which have been thoroughly tested in pilot operation.

Koppers engineers now are convinced that the machine can be successfully adapted to cast all ferrous-metal types, including mild steels, although greatest savings to steel companies will accrue in continous casting of specialty steels.

Operation of the continuous casting machine starts, of course, with adequate facilities for melting. From these facilities, the molten metal is

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

In the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

How Reducing Tool Hardness Tripled Output

A container manufacturer had been using several different grades of tool steel for rolls used to seam 18-gage sheet steel. The rolls didn't hold up very well. Asked to study the problem, we recommended our A-H5, a 5-pct-chromium, air-hardening grade.

But in treating the rolls the customer proceeded on the principle that a very high hardness would give longest wear—and hardened them accordingly. As a result they failed prematurely, due to breakage caused by inadequate shock-resistance.

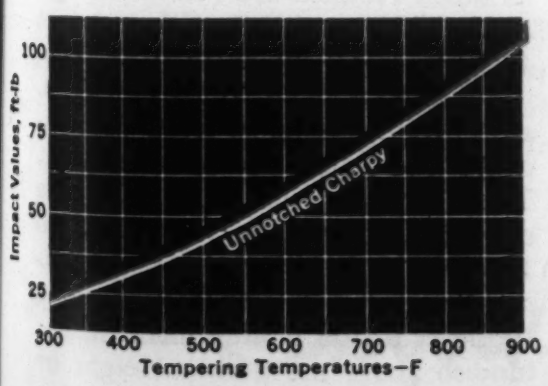
So we made the following recommendations for heat-treatment, asking that they be followed exactly: quench in oil at 1750 F, cool down to 1000 F, air-cool to 150 F, then temper for four hours at 1000 F and again at 950 F. This treatment produced a surface hardness of about Rockwell C-57.

"Not hard enough!" said the customer.

"Give it a trial," we urged.

The first roll so treated lasted nearly twice as long as any previous roll, making 58,000 seams on one groove with very little evidence of wear. A second roll made nearly 100,000 seams!

A tool that's close to its maximum hardness is likely to be brittle. And tools wear too rapidly if hardness is low. That's why most production tools and dies are treated so as to get an ideal compromise between hardness and toughness.



HARDNESS VS. TOUGHNESS — This curve shows how the impact-resistance of a carbon tool steel increases as the hardness is reduced by higher tempering temperatures.

Our modern mill depot is geared for fast shipments of tool steel to distributors everywhere. A wide selection of sizes is stocked in 22 grades of steel.

TOOL STEEL...WHEN YOU WANT IT!

Distributors of Bethlehem tool steel are ready to fill your tool-steel orders from their local stocks . . . in strategic cities throughout the country. Our own mill depot at Bethlehem, Pa., is completely stocked with several thousand sizes of 22 different tool-steel grades for quick shipment to our distributors and to mill customers. Whether you need one short bar or a carload, you can count on fast delivery when you specify Bethlehem.

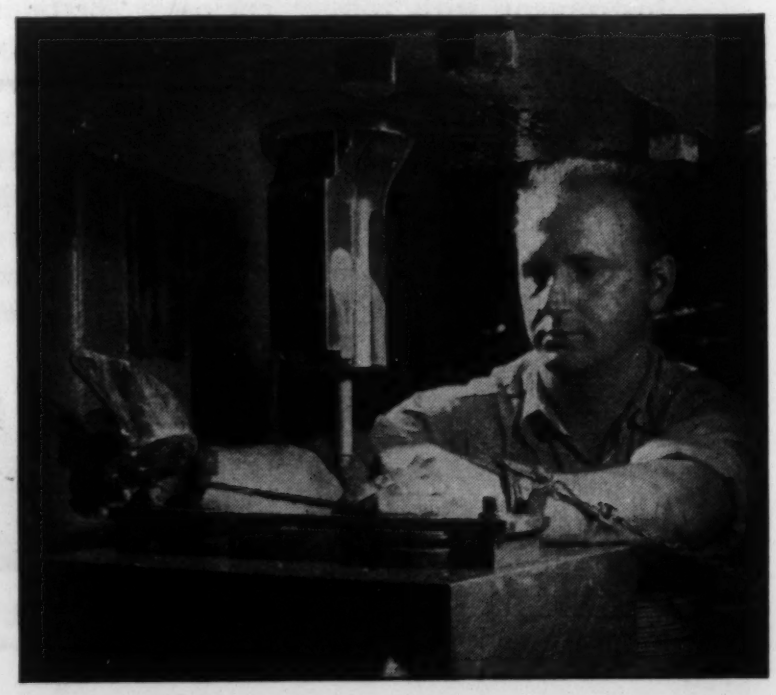
Our complete line includes: carbon and carbon-vanadium, oil- and air-hardening, shock-resisting, hot-work, high-speed steels . . . and steels for die-casting dies, plastic molds, brake dies and other special applications.

And remember — Bethlehem metallurgists are on call whenever you have tool-steel problems.

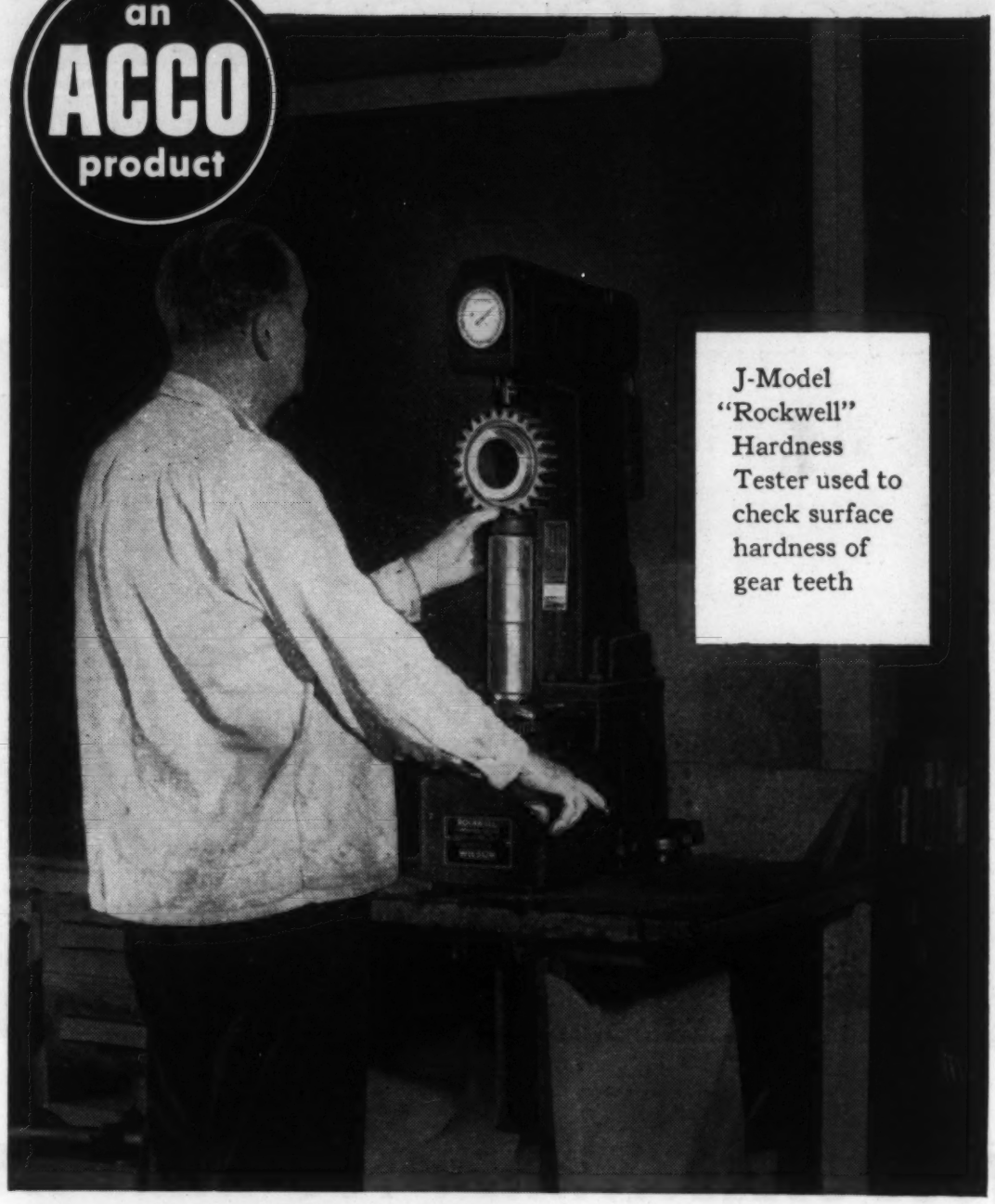
HEAVY-DUTY PUNCH

Made of our 67 Chisel, this punch forms parts from .185-in. sheet steel in a 300-ton hydraulic press. The punch must take a lot of shock; and that's why this chrome-tungsten tool steel stands up so well. It's hardened to Rockwell C-58.

The lower die, hardness Rockwell C-61, is made of Lehigh H—our popular grade of high-carbon, high-chromium steel. About 5000 pieces are produced on this heavy-duty job before redressing is required.



an ACCO product



J-Model "Rockwell" Hardness Tester used to check surface hardness of gear teeth

How "ROCKWELL" Hardness Testers Reduce Customer Complaints

● Surface hardening of wearing parts makes them last longer but it is a job requiring skill and precision. The eye cannot detect inaccuracies but a WILSON "ROCKWELL" hardness test leaves nothing to chance.

The WILSON "ROCKWELL" Hardness Tester is a precision instrument with totally enclosed "Zerominder" dial, gripsel clamp screw for quick change and proper seating of penetrator, conveniently grouped controls, enclosed variable speed dash pot, and standardized weights.

Regular and Superficial WILSON "ROCKWELL" Hardness Testers come in many styles with accessories for testing flats, rods, rounds, odd shapes.

There is the WILSON TUKON for micro-indentation hardness testing. Write for literature.

*Trade Mark Registered

ACCO

WILSON MECHANICAL INSTRUMENT DIVISION
AMERICAN CHAIN & CABLE

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230-E Park Avenue, New York 17, N. Y.

WILSON "ROCKWELL" and TUKON Hardness Testers

News Digest

transferred to the machine and poured into a refractory-lined vessel. This vessel or tundish has a nozzle at the bottom which directs the metal into a copper mold.

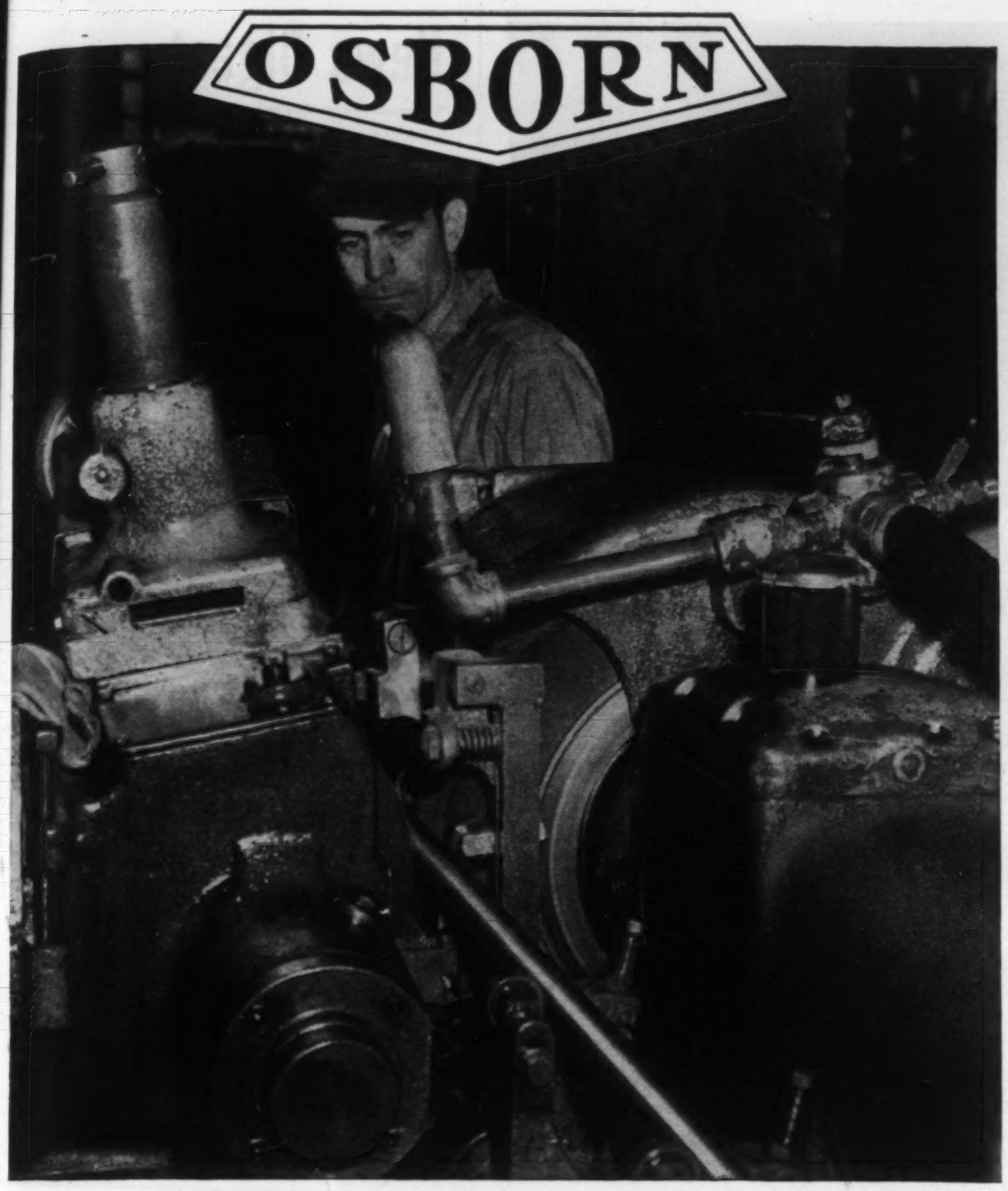
The walls of the copper mold contain drilled passages through which water is circulated in order to extract the heat from the solidifying metal. An essential part of the process is the mold oscillation in which the mold moves downward with the casting for a certain distance and then returns quickly. This action keeps the metal from sticking to the mold as it hardens and increases the mold efficiency.

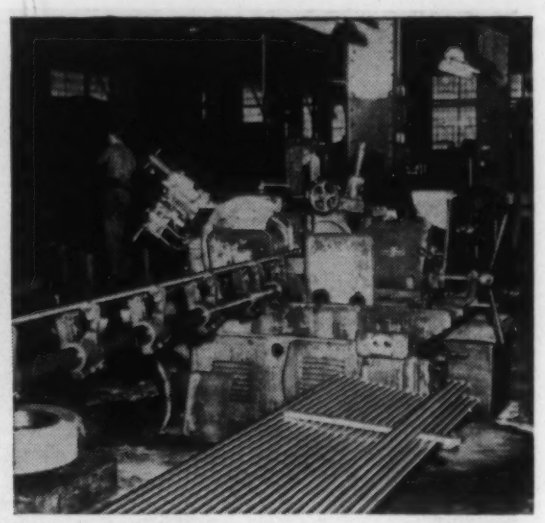
In order to start the casting operation, a dummy billet or slab of nearly the same cross section as the casting is inserted halfway into the mold from the bottom. The end of the dummy in the mold is packed to prevent molten metal leaking down the sides as the first metal is poured into the mold. When the mold is nearly filled, the machine is started, the pinch rolls draw down the dummy with the new formed casting attached and continuous casting is underway.

As the casting emerges from the bottom of the mold, it passes through water sprays which complete solidification, and through withdrawing rolls which control the speed of casting. Below these rolls is the acetylene torch, which automatically cuts the casting to desired length.

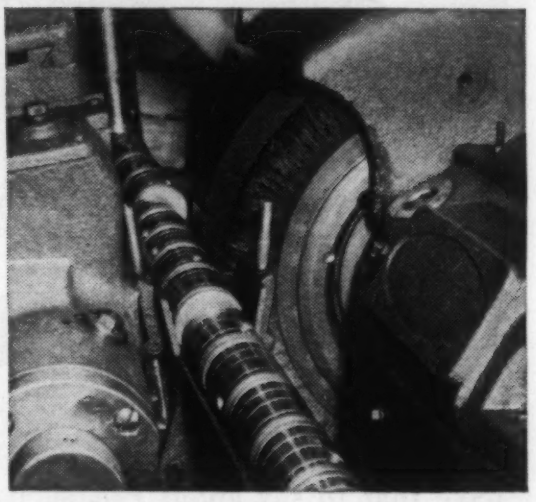
From the cutting torch, pieces are received by a mechanical device which delivers them from the pit beneath the machine to a conveyor above ground. The discharged pieces are now ready for conditioning if necessary, reheating and rolling to finished sizes.

Koppers will build the continuous casting machine for Atlas Steels at its Metal Products Div. in Baltimore, Md. This machine will produce 4¼- by 4¼-in. billets; 5½- by 7½-in. billets; and 5½- by 21½-in. slabs. With different molds, the machine also could produce rounds. The Atlas Steels machine is capable of casting at speeds from zero to 100 in. per min. Metal flow is regulated by increasing or decreasing the level of the molten metal in the tundish above the mold. Height of the machine will differ in various installations, depending on the cross





THE SET-UP. This shows the centerless grinding machine which also serves as a "centerless brusher". These pump rods vary from 1⅛ in. to 1½ in. diameter . . . from 6 ft. to 36 ft. in length. Regulating wheel speed is 52 r.p.m.



ANOTHER JOB. Here Centerless Brushing finishes cast iron pistons to micro-smoothness. Simplifies assembly operations and increases life of pistons and cylinders. Output of this machine is 10,000 pieces per 8 hours.

Finer finish . . . longer product life with Centerless Brushing

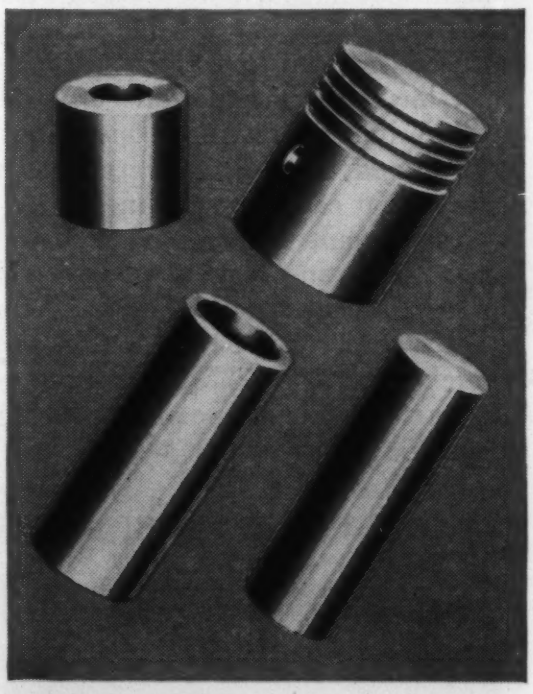
This machine does double duty. For removal of metal to close tolerance, it is a *centerless grinder.* Then, for finishing the surface to micro-smoothness it is a *centerless brusher.* Its conversion takes only a few minutes.

In the operation shown above, nickel-moly steel rods for pumps, are being finished by an Osborn Fascut Brush. Prior to brushing, the same machine with a grinding wheel in place of the brush made a rough grind, taking off .006 inch, and a finish grind, taking off .002 inch. Results of the Centerless Brushing: Produces a smoother finish. Reduces wear in pump packing. Reduces corrosive action on rods; makes them last longer.

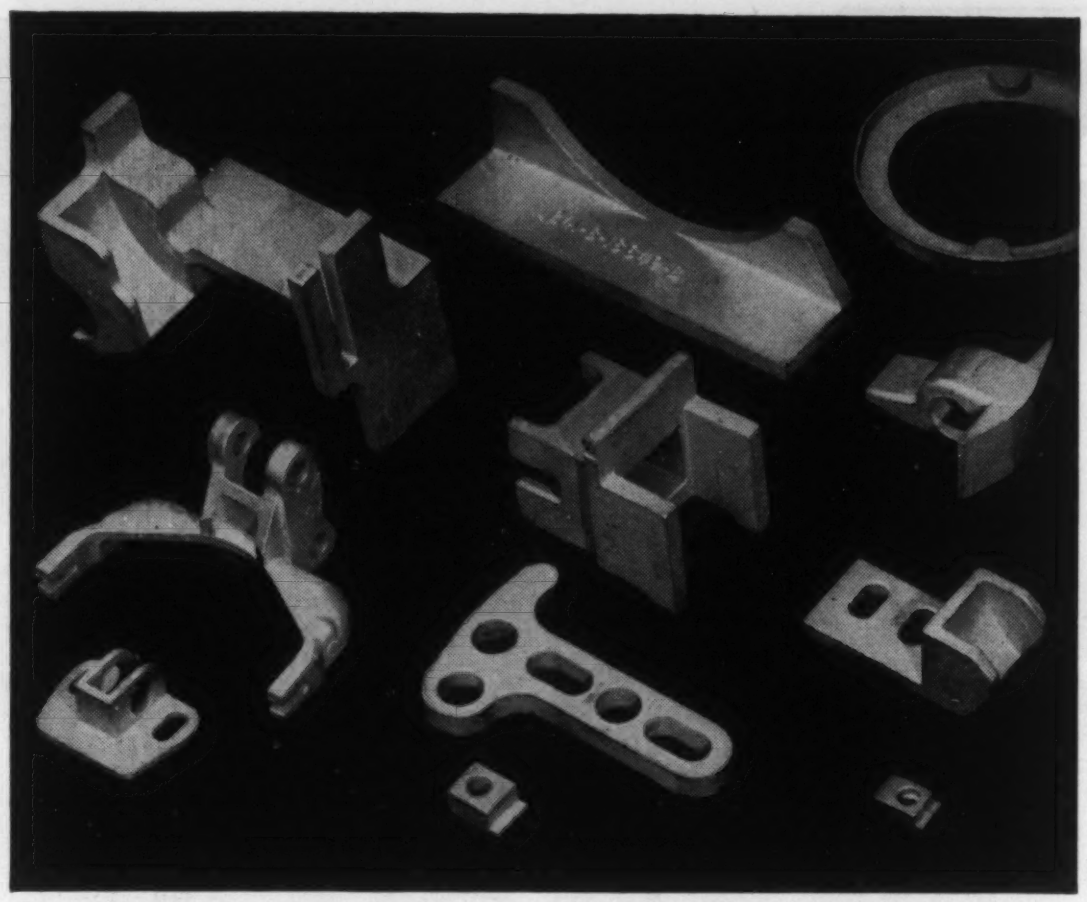
An **O**sborn **B**rushing **A**nalyst helped develop this improvement. Ask your **OBA** to help *you* on all problems of cleaning and finishing! Call him today or write *The Osborn Manufacturing Company, Dept. 894, 5401 Hamilton Avenue, Cleveland 14, Ohio.*

Osborn Brushes

OSBORN POWER, MAINTENANCE AND PAINT BRUSHES AND FOUNDRY MOLDING MACHINES



TYPICAL PARTS which are being improved by Centerless Brushing include pistons, piston pins, bushings, tubing . . . any cylindrical parts. It can be applied to many sizes of parts and types of material on a mass production basis.



"..accuracy and excellence of workmanship found only in exceptional organizations."

Dalmo-Victor Company of San Carlos, California, makers of electronic equipment, have that to say about Precision Metalsmiths. Pictured above are a few of the *investment castings* which have earned this high compliment.

Their further comment, "We are expecting a large increase in our use of such castings", is a thought heard often after manufacturers have discovered these facts: Intricate parts, not possible with any other process, can be investment-cast; designers can let their imagination run wild. Many machining and assembly operations can be eliminated and, often, parts are made in alloys that can't be machined.

Investment castings save you money, too: 21¢ against a previous 69¢—75¢ compared to a former $2.17—$2.80 for a part that would cost at least 3 to 4 times that much by the next cheapest process—$10.50 for a part made in one piece which couldn't be made by any other method.

Say "when"

you're worried about high costs

and we'll send you this free book

PRECISION METALSMITHS, INC., 1077 East 200th St., Cleveland 17, Ohio

pour yourself an assembly with

PRECISION METALSMITHS INC.

INVESTMENT CASTINGS

News Digest

section cast and length of pieces cut. In the Atlas installation, the height from plant level to machine operating floor is 30 ft.

Joseph Becker, vice president and general manager of Koppers' Engineering and Construction Div., said that development work on the machines will be pursued continuously to further develop techniques and broader uses.

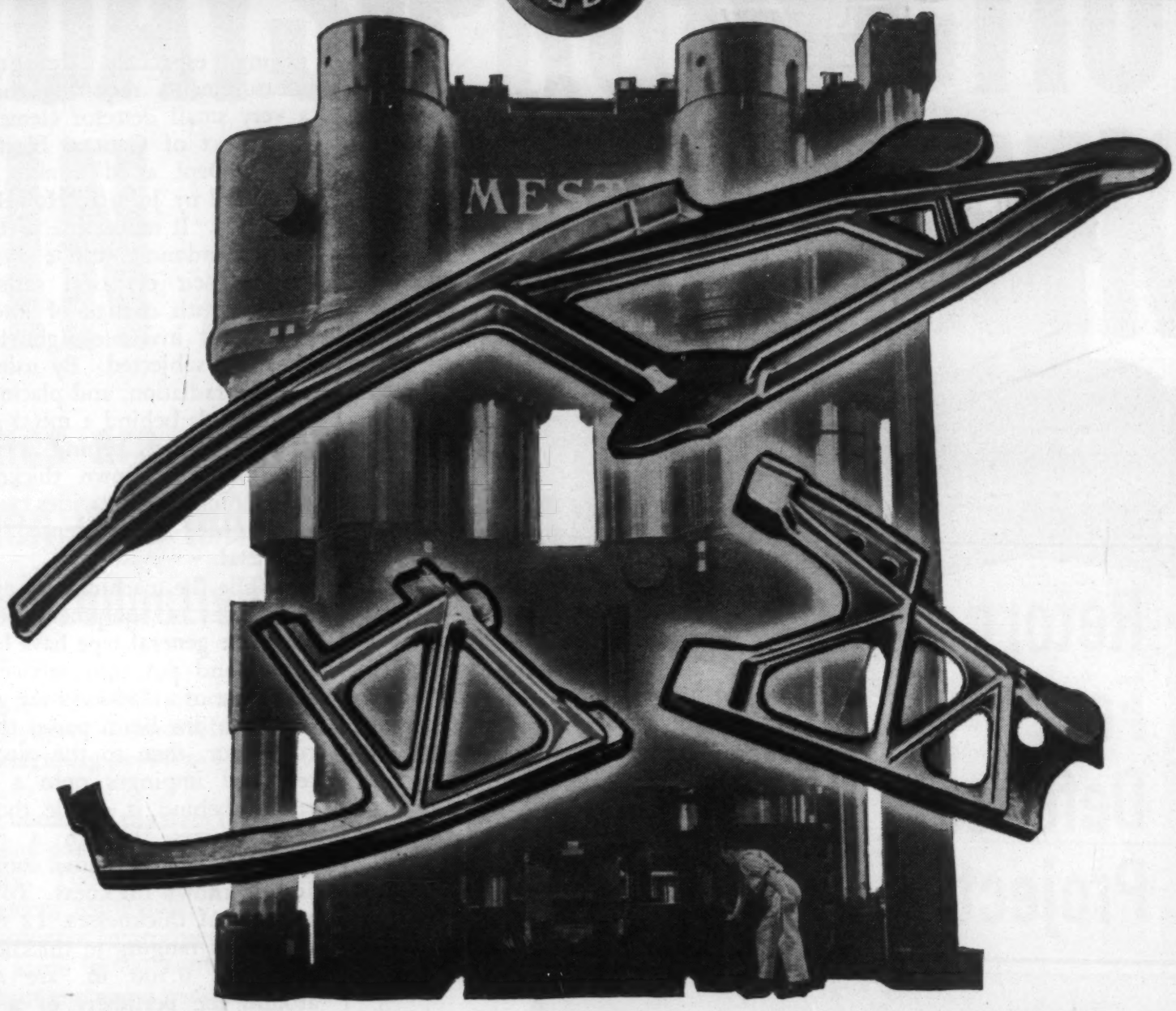
"Koppers does not believe, however, that these machines will outmode blooming mills and soaking pits throughout the steel industry," Mr. Becker said. "In many large operations with ordinary steels, smaller savings could be effected through use of continuous casting. For making higher priced steels and in some cases, such as where present blooming mill capacity is not up to melt furnace capacity, the machines will provide substantial savings, which will become even greater as more practice results in improved techniques."

X-Ray Gages for Inspection and Measuring

A number of papers presented before the Eighth Annual Electronics Conference at Chicago concerned the use of x-ray gages for inspection and measuring. A resumé of these papers follows:

When measurements must be made inside cavities difficult of access, or inspection for voids inside closed containers is required, the use of x-rays suggests itself as one possibility. X-ray examination by the usual photographic method is both costly and time-consuming. Several devices have been announced, however, that provided an indication of x-ray results at once, and without the cost of making a photographic record. Both are comparator-type instruments in which the measurement or indication is obtained by the differential result of two x-ray beams striking sensitive crystals after passing through the test specimen, or through the test piece and a reference specimen.

The first is an instrument for metal



Greater Size and Speed in Aircraft have created engineering problems, the solution of which has required larger and larger forgings of high-strength aluminum alloy. *Examples* shown above are forged structural members used in a modern military bomber, the largest more than seven feet over all. These are forged on an 18,000-ton press, the biggest ever built in this country.

Wyman-Gordon Experience—the most extensive in the industry—is keeping abreast of new forging demands involving the use of Steel, Aluminum, Magnesium, High Density Alloys and Titanium.

• • •

Standard of the Industry for More than Sixty-five Years

WYMAN-GORDON

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN

DURASPUN

30% Cr.
20% Ni.
1% Mo.

Retort For Defense Project

Perhaps the most interesting feature of this Duraspun High Alloy Casting is that four different sizes of centrifugal castings are involved. These vary from 34" to 3½" in diameter. Sections, outlets, collar bands, lugs etc., were all welded together in our shop to form the retort as you see it in the picture. Assembled weight runs around 7,464 pounds.

High alloy castings is our business—not merely the adjunct of an extensive steel founding business. We have the experience — 30 years in the static casting division and 20 years on centrifugal castings. We pioneered both kinds of castings in this country. And we have excellent testing and checking facilities, including a 400,000 volt X-ray machine and gamma-ray units.

If you would like this combination of wide experience, modern shop practice, up-to-date equipment and full testing facilities working on your next high alloy casting, bring it to us.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • Eastern Office: 12 East 41st Street, New York 17, N.Y.
Detroit Office: 23906 Woodward Avenue • Pleasant Ridge, Mich.
Atlanta: J. M. TULL Metal & Supply Co. Chicago: F. O. NELSON 332 S. Michigan Avenue San Francisco: JOHN D. FENSTERMACHER 1241 Taylor Street
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News Digest

gaging especially designed for measurements requiring the use of a very small detector element. It is a product of General Electric Co.'s X-Ray Dept. at Milwaukee, and was described by John F. Howell of that company. It makes use of the property of cadmium sulfide crystals that causes their electrical resistivity to change with change of intensity of visible or invisible light to which they are subjected. By using x-rays for the radiation, and placing one of the crystals behind a metal specimen and the other behind a reference specimen of known thickness, the differential in resistivities can be read or recorded as differential thickness of metal.

While the machines are not standard pieces of equipment, several of the same general type have been produced and put into service. These make use of a 250-kv x-ray generator in which one beam passes through a collimator, then to the piece under test and impinges onto a detector crystal behind it, while the second beam passes through a reference specimen of the same composition and of known thickness. To provide a range of thicknesses, 12 reference specimens ranging in thickness from 0.075 to 0.500 in. are mounted around the periphery of a disk so that any one of them can be rotated into the path of the x-ray beam. The difference in the amplified output of the two crystals is recorded on a meter which can be calibrated to read in thousandths of an inch.

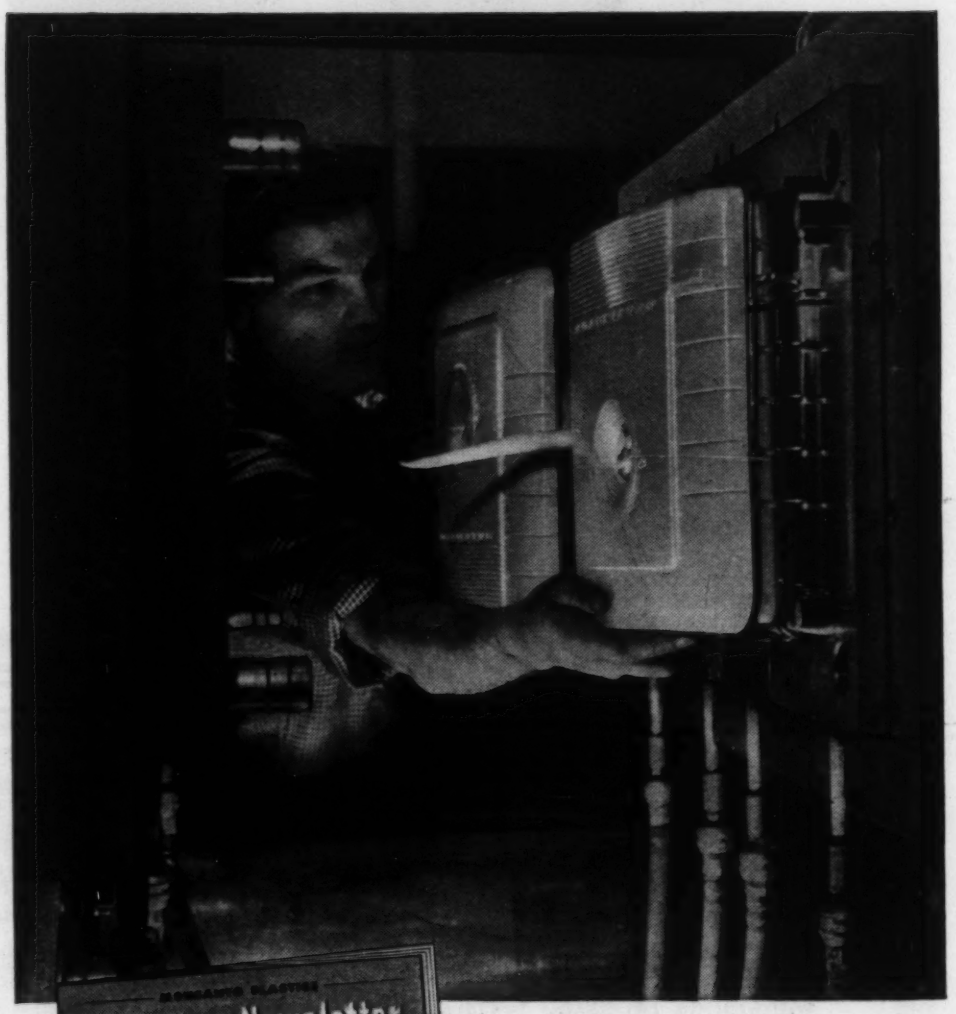
As designed, the gage covers the range from 0.070 to 0.500 in. in 12 steps, and can provide thickness readings within this range with an accuracy of $\pm 0.5\%$. Two scales are provided, one for measurements over a wide range and having a range of $\pm 20\%$ from the thickness of the standard, the other for more accurate readings and having a range of $\pm 10\%$ from thickness value of the standard.

The maximum practicable thickness of metal that the gage can measure is determined by the rating of the x-ray generator. At thicknesses of less than about 1/16 in. the variables, such as material composition and x-ray regulation, begin to affect accuracy to an appreciable degree.

The cadmium sulfide crystals are each mounted in series with a resistor, and a d.c. potential of 200 to

7 DAYS' PRODUCTION IN A 5-DAY WEEK

Plastics are a "lifesaver" to men who must raise productivity today

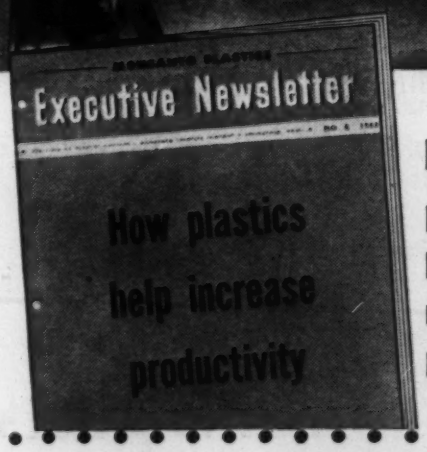


How to pare production costs... how to increase plant efficiency–in short, how to raise *productivity* is an overriding problem for most manufacturers today.

Your choice of plastics materials could play an important part in solving this problem for your company. Today's modern plastics are Basic Engineering Materials . . . used by hundreds of manufacturers to produce *more* of a *better* product for the same investment in men and machines; or more of the same product at *lower cost*.

Whether tiny electronic tube sockets or giant refrigerator doors, manufactured parts and products are molded of plastics in fast, automatic machines. "One-shot" jobs are the rule...with machining, painting, assembly, and other expensive finishing operations eliminated or materially reduced.

This is only *part* of the story. It'll pay you to thoroughly investigate plastics for your product –today. Send for Monsanto's latest Executive Newsletter which contains a report on how plastics help increase productivity. And, call on the Monsanto Technical Council—a board of experts in plastics—for assistance with your individual problem. The coupon is for your convenience.



FREE—Report to Design Engineers

Monsanto's Executive Newsletter, with the latest information on plastics, is mailed regularly to engineers. Have your name placed on the mailing list.

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CHEMICALS AND PLASTICS

SERVING INDUSTRY . . . WHICH SERVES MANKIND

MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2224
Springfield 2, Massachusetts.

Please send me Monsanto's Executive Newsletter with the report on how plastics help increase productivity.

Name & Title _____

Company _____

Address _____

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POWDERMET SUCCESS STORY NO. 17

HOLDING LOCK PLUG TOLERANCES TO ±.0005"!

Formerly the manufacturer had to broach these small lock plugs in order to hold a tolerance of plus or minus .0005". Naturally the machining operation was costly and time-consuming. It was obviously desirable to use powdered metal but because of the extremely close tolerances it was considered unworkable.

Then they came to Powdered Metal Products Corporation of America and discovered PMP could supply plugs to the required tolerances and still substantially lower the cost. There was no sacrifice of quality or wear characteristics. In fact the PMP plug withstands repeated tests of over 500,000 cycles—much more than encountered in normal use.

If you have a problem involving production parts, why not consult Powdered Metal Products? Their complete facilities assure finest results.

Write today for complete information.

sign of leadership PMP* in powder metallurgy

POWDERED METAL PRODUCTS CORPORATION of America

9335 West Belmont Avenue,
Franklin Park, Illinois

*Trademark

News Digest

300 volts is applied across each. The relatively low voltage requirement and the small size of the crystal mount are decided advantages in use. The crystal probe to be used behind the sample being tested can be maneuvered in narrow spaces inaccessible to most electronic gaging units.

In the manufacture of aircraft propeller blades, the hollow steel blade is extrduded with a wall thickness uniformly decreasing from the hub to the tip. Uniformity is important for proper performance of the blade at high speed. Gaging the wall thickness was formerly done with a pair of 18-ft. calipers, and required about 8 hr. It was inefficient at best, as readings were taken at selected intervals along the length of the propeller, and the method gave no indication of variation between these intervals. With the X-ray Comparator Gage, the probe holding the detector crystal is moved along the inside surface of the wall of the propeller and a continuous reading is obtained on the instrument gage.

The cadmium sulfide detector is used in other instruments to measure the height of fill in cans of food or other material; for inspecting fuze trains for voids; for detecting voids in various types of sealed containers.

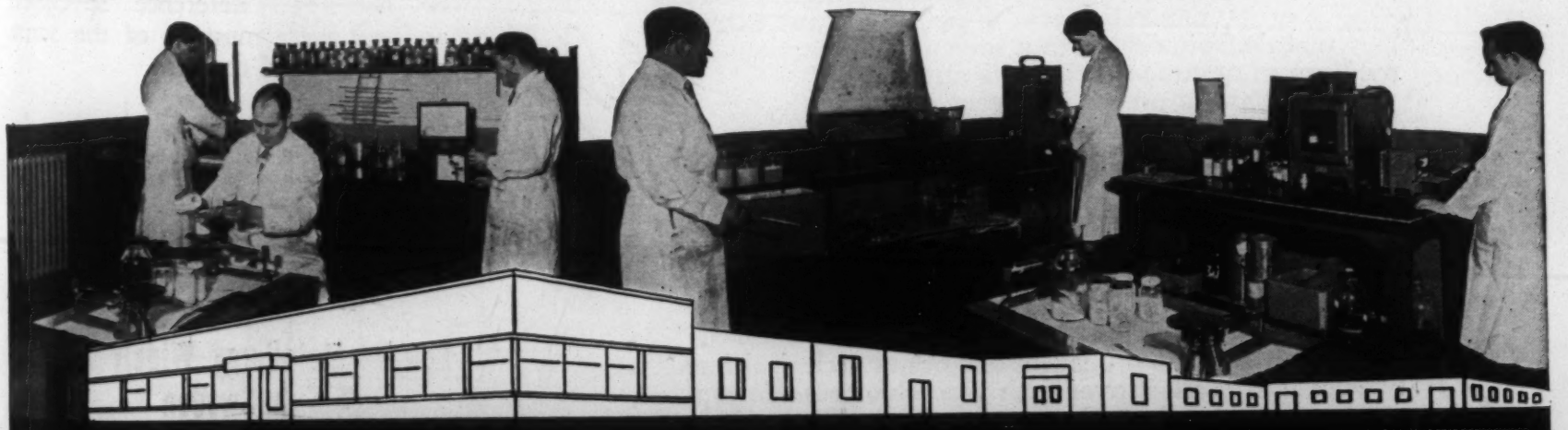
The second x-ray gage is a differential absorption instrument described by George M. Ettinger, of Standard Electronics Research Corp., New York. It resembles the first in that two detector crystals are placed in an x-ray beam, and their differential reactions are compared by the instrument meter. In this second gage, however, the crystals used are scintillating crystals of potassium iodide, which emit visible light when subjected to x-ray treatment. As the amount of visible light emitted is approximately proportional to the intensity of x-ray radiation reaching the crystal, this light will serve as a measure of the amount of x-ray transmission through the sample. The amount of light emitted by each crystal is measured by photomultipliers which are connected to a d.c. meter and a chart recorder. Any differential in transmission of x-rays through the sample is, therefore, indicated on the instrument meter.

This gage has been used success-

. . . on our Twentieth ANNIVERSARY

we wish you a Very Merry Christmas

Since our birthday, December 7, 1932—as much has happened as in twenty centuries before—it has been an era of great glory, great tragedy and of our greatest industrial and economic expansion . . . . . In our field NORTHWEST has built a very substantial and loyal following because we have learned to do this job of metal cleaning more thoroughly than it was ever done before. . . . . On our Twentieth Anniversary, we want to take this opportunity to thank you for this fine testimonial to our ability to solve such problems and we are going to 'leave no stone unturned' to merit your continued support. . . . . Send for twenty-four page brochure that describes all of the NORTHWEST Chemical products.



LO HI pH

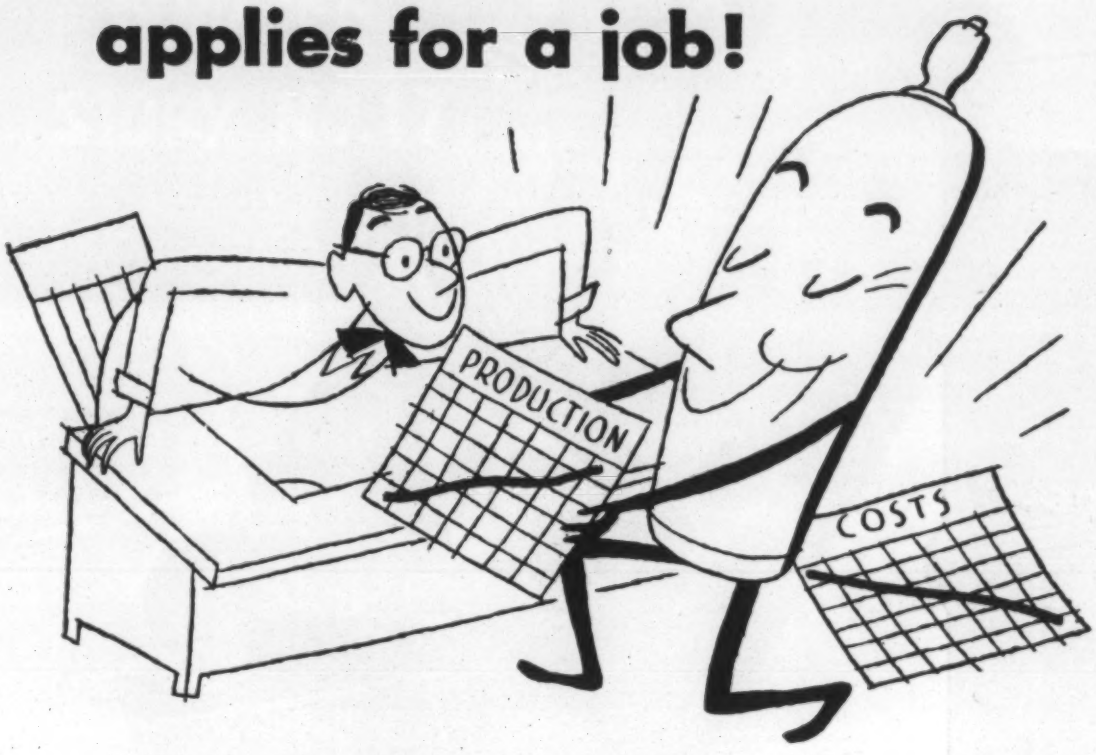
NORTHWEST CHEMICAL CO.

9310 ROSELAWN DETROIT 4, MICH.

pioneers in pH cleaning control — serving you since '32

Amazing Ammonia

applies for a job!

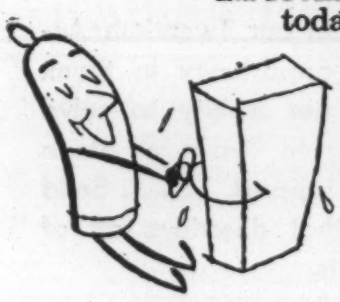


If ammonia, the versatile chemical, applied for a job, the interview would probably go like this:

EMPLOYER: How old are you?

AMMONIA: Many centuries. I helped the ancient Egyptians bleach cloth 3,000 years ago.

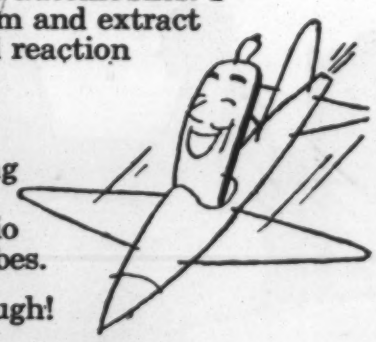
EMPLOYER: Amazing! But what do you do today?



AMMONIA: I grow farm crops, make ice, purify water, produce explosives.

EMPLOYER: I know you are a fertilizer, a refrigerant, and . . .

AMMONIA: Yes, and I serve as a protective atmosphere to surface-harden and anneal vital parts of planes and automobiles. I neutralize acid in petroleum and extract metals from ores. I'm a solvent and reaction medium in organic synthesis, a nutrient for yeast and a processing agent in the manufacture of alkalis, rayon, dyes, butadiene, and catalysts for cracking petroleum. I'm used in making vitamins, sulfa-drugs and radio and television parts and tubes.



EMPLOYER: Whoa—that's enough! What can you do for us?

AMMONIA: Just let one of our technical men talk it over with your chemists. He can usually find an answer that will speed up some process and save you dollars.

Barrett* Brand Anhydrous Ammonia in Cylinders

FORMERLY SOLD BY THE BARRETT DIVISION
NOW SOLD BY

Nitrogen Division

ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

*Reg. U. S. Pat. Off.

News Digest

fully to detect voids in the fill of explosive in 3.5 in artillery projectiles. The projectiles move into the x-ray beam one by one, and each is rotated in the beam at a rate that will permit signal pulses separated by about 0.2 sec to be recorded. For this purpose, the crystals are mounted 3/16 in. apart, and the x-ray generator produces short pulses of x-rays at a repetition rate of 60 cycles per sec. Because the crystals were so close together and the diameter of the photomultiplier tubes was rather large, the light emitted from the crystals was carried by methyl methacrylate plastics guides from the crystals to the tube windows. To avoid a blind spot in the volume tested, one of the beams passes through the center of the projectile, and the other at a small angle so as to impinge upon the second crystal 3/16 in. to one side. Voids in the charge as small as 0.0001 cubic inches have been detected and recorded by this device, rapidly and automatically.

The gage can be used as a thickness gage as well as for fault detection. By changing the mounting of the detector crystals and passing one beam through a reference specimen of known thickness, while the other beam passes through the test specimen, the differential can be recorded as difference in thickness. A discrimination of 0.0005 in. of steel in 0.25 in., or one part in 500, can be obtained. Reference specimen and test piece must be of the same composition, of course.

Powder Metallurgy Widely Applied in Sweden

A special report to the Metal Powder Association has been made by Dr. Henry H. Hausner, manager of Atomic Energy Engineering, Sylvania Electric Products, Inc., and Adj.-Prof. at the Polytechnic Institute of Brooklyn. It is the result of his visit to Europe this summer to attend the International Mechanical Engineering Congress at Stockholm and the Seminar "De Re Metallica" at Reutte,

ON MINNEAPOLIS-MOLINE'S UNI-HARVESTOR...

SHAFT SIZE REDUCED from 1½" to 1¼"

BY USING **HIGH-STRENGTH GROUND AND POLISHED**

STRESSPROOF®

INSTEAD OF C1045

The UNI-HARVESTOR is really different. It harvests grains, beans, and all seeds—it picks and husks corn, and bales or chops hay. Ground and Polished STRESSPROOF is specified for the cylinder shaft.

●In designing this Cylinder Shaft, Minneapolis-Moline engineers specified Ground and Polished STRESSPROOF to meet the increasingly severe operating conditions to which this equipment is subjected. The alternative would have been lower strength shafting with an increase in size. The larger shaft would have been 44% heavier, and bearings and gears would have had to be redesigned. Ground and Polished STRESSPROOF proved to be stronger, had better fatigue properties, and machined better. It eliminated heat-treating and straightening operations, and the size accuracy provided a correct bearing mounting.

STRESSPROOF makes a better part at lower cost.

STRESSPROOF is a severely cold-worked, furnace-treated, carbon steel bar with a unique combination of four qualities in the bar: (1) Strength, (2) Wearability, (3) Machinability, and (4) Minimum Warpage. Yet it costs less than other quality cold-finished steel bars. Available in cold-drawn or ground and polished finish.

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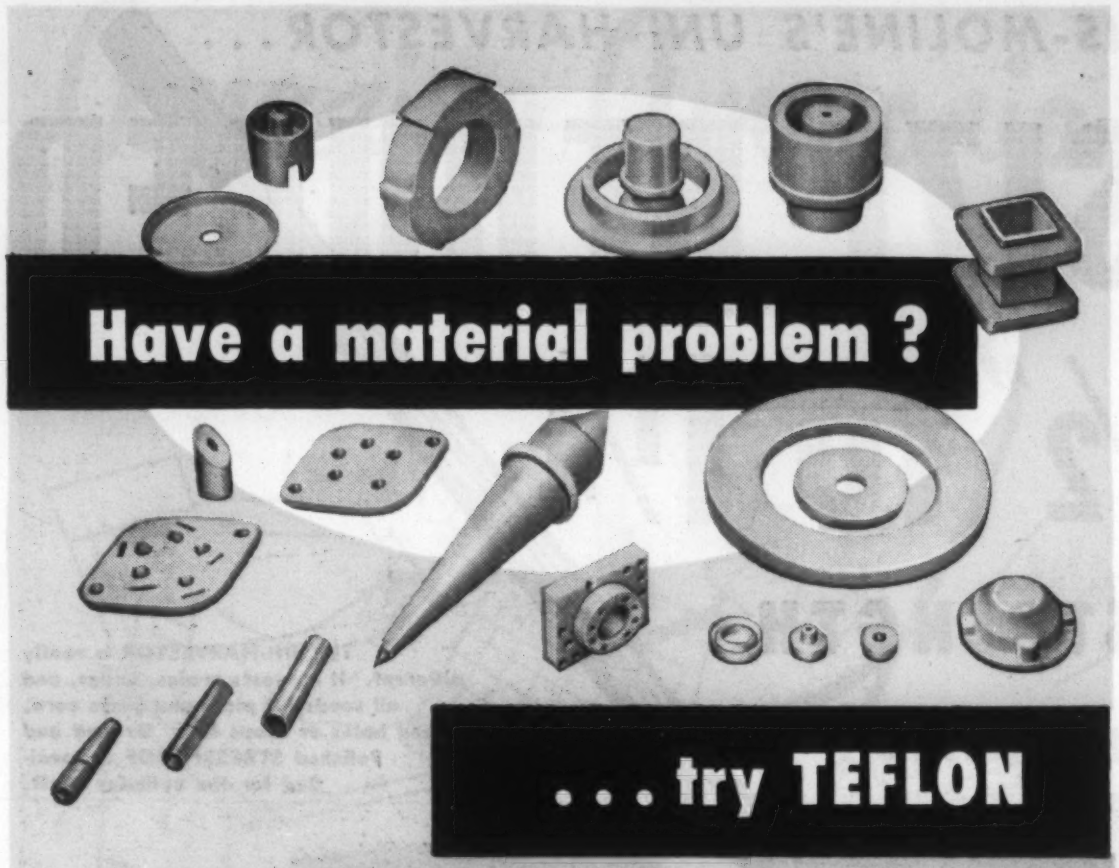


Pure Teflon* and Chemelec Mixtures, which are "alloys" of Teflon, offer product engineers a whole new family of materials.

Undoubtedly you are familiar with the properties of pure Teflon — its chemical inertness, its unapproached dielectric qualities, its serviceability at temperatures from —110° F. to 500° F., its extreme anti-hesiveness, its zero water absorption.

Now, Chemelec Mixtures further broaden the scope of this wonder plastic. If you want Teflon that can be soldered or cemented, you may have it. If you want Teflon, "alloyed" with metal, glass, ceramics, carbon, mica, quartz, alnico, asbestos, silicate, calcium, or boron, etc., to meet a particular material requirement, you may have it, too.

Bring us your problem and our engineering department will work with yours to determine the material best suited to your needs.

***du Pont's trademark for its tetrafluoroethylene resin**

News Digest

Tyrol. The following is the report:

Powder metallurgy development in Sweden is greatly affected by two facts: most of the powder metallurgy parts are made from iron and steel, and a great number of them are characterized by the skill of their mechanical design.

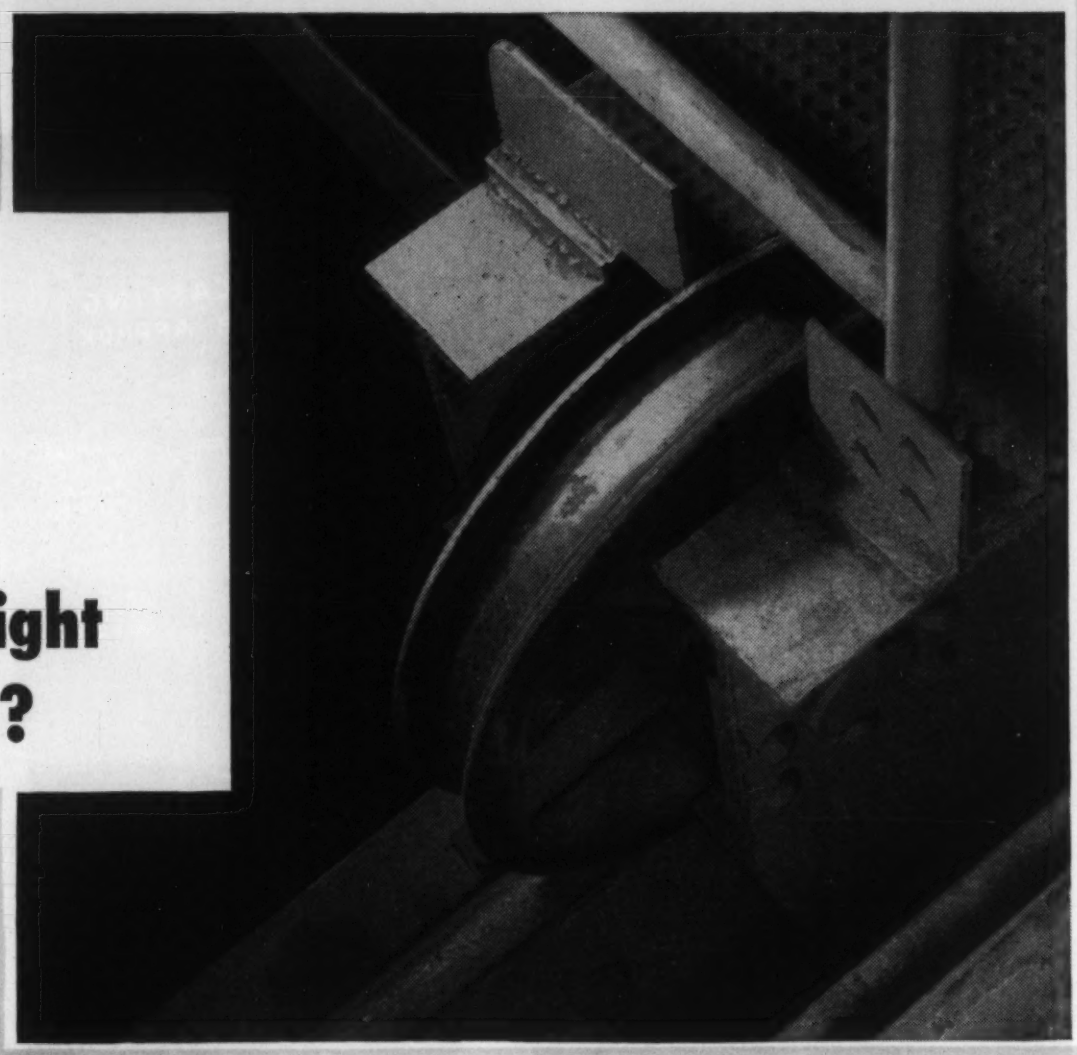
The importance of powder metallurgy in Sweden is best shown by the fact that two important powder metallurgical conferences took place in this country within the first two weeks of June of this year. The International Mechanical Engneering Congress was held in Stockholm June 4th to 10th, 1952. The topic chosen for this Congress was "Raw Materials" or, more explicitly, "The Study from the Designer's Standpoint of Improvements in the Raw Materials Used in Various Branches of Manufacturing."

One day of this Congress was exclusively devoted to the "Reactivity of Solids;" it was held in Gothenburg June 9th to 13th, 1952. Papers on the fundamentals of powder metallurgy and ceramics, such as diffusion, recrystallization and others were presented and were widely discussed. Several hundred scientists and engineers from Sweden and from practically all the other free nations attended these meetings.

Research in powder metallurgy is mostly done at the universities. The center of research is Chalmers University of Technology in Gothenburg. The powder metallurgical research work is done at the Ceramics Dept. of this University under the leadership of Professor Arvid Hedvall, whose books on the reaction between solids have found world-wide distribution. His latest book, Introduction into the Chemistry of Solids," was published in June of this year. Other research in the fundamentals of powder metallurgy is done at the famous old university of Uppsala (Professor Haegg and Professor Kiessling). This research concerns mostly the structures of carbides and borides.

Surprisingly little basic research in powder metallurgy is done at the Swedish industrial laboratories, although the industries in Sweden are growing, and produce some of the most interesting sintered parts. There are exceptions, such as Glissa or Hoeganaes, which will be discussed in the following paragraphs.

Most of the powder metallurgy



PRODUCT—
Crane Wheel

MATERIAL—
Steel

EQUIPMENT—
1000 kv x-ray unit

What's the right X-ray film?

KODAK INDUSTRIAL X-RAY FILM, TYPE A

Failure of any of this crane's wheels would stymie the smooth production of the plant. So the smart order was "Radiograph them."

To make the radiographs, the radiographer used 1000 kv, 4-min. exposure at 8-feet tube distance, and Kodak Industrial X-ray Film, Type A.

This film has fine graininess with high contrast and sufficient speed to take full advantage of high kilovoltage equipment in radiographing thick or dense materials. It is also first choice for the examination of light alloys with short exposures at low voltages.

A TYPE OF FILM FOR EVERY PROBLEM

To provide the recording medium best suited to any combination of radiographic factors, Kodak produces four types of industrial x-ray film. These provide the means to check castings and welds efficiently and thus extend the use of both processes.

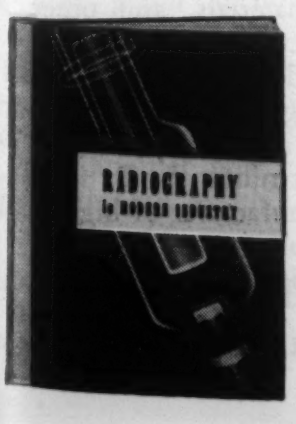
Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage and for examining heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

Radiography . . . another important function of photography



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

EASTMAN KODAK COMPANY
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Kodak
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FOR Westinghouse!

Westinghouse Electric Corp. recently required a part for use on oil circuit breakers. Their rough blueprint called for a link composed of three separate units which had not only to be machined, but welded together.

Atlantic's engineers suggested a design that resulted in a part cast in ONE PIECE from Atlantalloy #31 High Tensile Manganese Bronze . . . a dependable engineering material that is stronger than many steels. This one piece casting eliminated the involved machining, welding and finishing steps—and consequently afforded a substantial saving over former costs.

Write for a copy of "Quality Precision Castings for Industry" today. This booklet shows how the plaster mold process cuts production costs and includes specifications on Atlantic's alloys.

ATLANTIC
Established 1937
CASTING and ENGINEERING CORP.
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News Digest

production concerns iron and steel parts made from the famous Swedish sponge iron powder. This low-priced, high-quality iron powder is a product of Hoeganaes-Billesholms A. B. Hoeganaes has been producing sponge iron since 1911. In 1951, more than 11,000 tons of Hoeganaes sponge iron powder were used in the U.S.A. (approximately 5,000 tons were used in Europe).

Electrolytic iron powder is produced by Husqvarna Vapenfabriks A. B. The production in 1951 was approximately 750 tons. Husqvarna manufactures, among others, bicycles, sewing machines and household appliances such as washing machines and refrigerators and also sporting shot guns. Many of their products contain powder metallurgical parts which are made by double pressing and double sintering. This technique permits the production of structural parts of close dimensional tolerances and of a perfectly finished surface. The parts are of high density, a tensile strength of 40 to 50 thousand psi and an elongation of 30 to 36%.

A. B. Glissa in Stockholm, a medium sized powder metallurgical plant under management of Dr. J. Heuberger, has a special position in the manufacture of sintered structural parts. Their main products are self-lubricating bearings and other self-lubricating parts. The processes used for compacting the powders are generally simpler than the processes used in the U.S.A. (although they use Stokes presses, also); therefore, the compacting dies are in many cases considerably more complicated and the ingenuity with which these dies are designed permits them to produce powder metallurgy parts of outstanding design. The mechanical skill and the abilities of these Swedish engineers result in power metallurgy parts of almost unbelievably complicated shapes. Glissa also produces sintered hard metals.

A. B. Svenska Metallverken, Vasteras, is known as a manufacturer of sintered plates for storage batteries, frictional materials, and other sintered products.

The powder metallurgy method of hot pressings is greatly developed and widely applied by Svenska Diamantbergborrnings A. B. in Stockholm, a manufacturer of high quality diamond tools.

The application of powder metal-

It's time to take a new look at the "working" plastics

The list of materials you could profitably use for a given product or part six months ago may be obsolete now.

In the field of phenolic plastics alone, recent Durez developments can offer you savings in production and assembly costs, improved product service, and greater salability.

A re-survey of the materials picture will show you, for example, that parts to be *metal plated* can now be molded from a new Durez phenolic having excellent physical properties. If you never used plastics because the 'service your products undergo is "too rough," we have another new material with impact strength as high as 20 foot-pounds per inch (Izod). This is more than double the impact you could get heretofore.

Perhaps you manufacture electrical devices using silver contacts? We have a new phenolic that eliminates the problem of contact corrosion.

These and other results of our continuing plastics research can be utilized conveniently. Custom molders of Durez can serve you from the rough-drawing stage on in... can deliver finished moldings that meet your most exacting tests.

Our field technicians are at your service. Just write.

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- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
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Our monthly "Durez Plastics News" will keep you informed on industry's uses of Durez. Write, on office letterhead.

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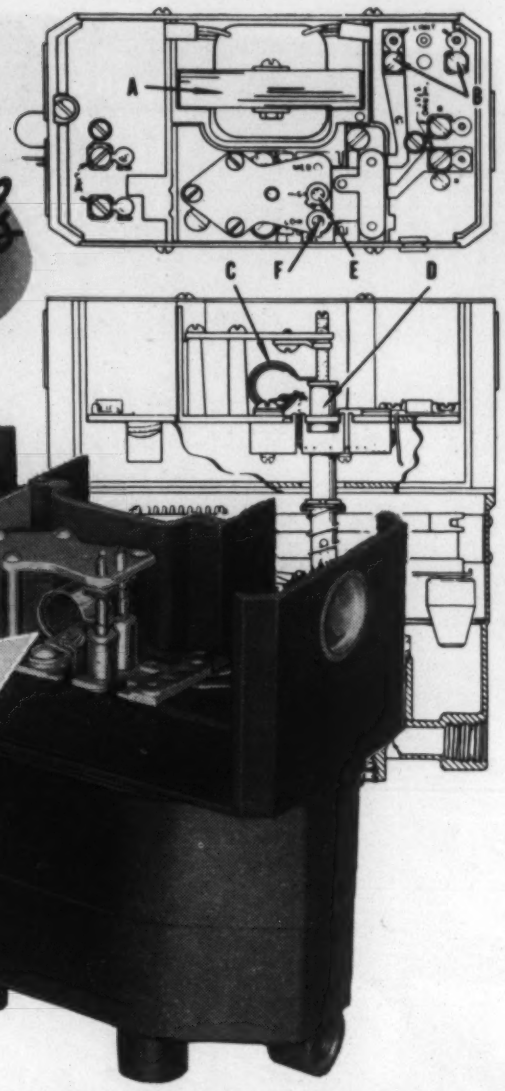
PHENOLIC PLASTICS THAT FIT THE JOB

DETROIT Controls

end furnace smoke and fumes— with CHACE BIMETAL



Product of: Detroit Controls Corporation
Established in 1877 as Detroit Lubricator Company

The CRC-239-F Series Detroit Furnace Controls are electrically operated float valves designed to control the flow of fuel to vaporizing pot type burners in accordance with the demands of an electric wall type thermostat. They incorporate in one compact unit all the mechanism necessary for thermostatically operating the flow control valve and switch mechanism which control the booster fan. This precise regulation of fuel eliminates smoke and carbon formations. The movement of the metering stem which controls the flow of oil to the burner is dependent on Chace Thermostatic Bimetal.

When the thermostat calls for heat it completes the circuit from the 24 volt secondary of the built-in transformer "A" through the limit switch connected to terminals "B" and a heat motor "C". When the heat motor is thus energized it operates the metering stem "D", allowing it to rise to high fire position. This stem moves to low fire position when thermostat opens the circuit. The limits within which the metering stem travels are set by adjusting screws "E", high fire, and "F", low fire.

If the actuating element for your new control device is thermostatic bimetal, Chace has the equipment and qualifications for fabricating it ready for assembly. Our 29 types of bimetal are available in strips, coils, random long lengths and welded or brazed sub-assemblies. We also provide specialized tooling for fabricating to your designs; our application engineers are available for consultation. Write for a copy of our new 32-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

News Digest

lurgy in the electrical industries was pioneered by Dr.Heuberger with the introduction of copper-graphite generator brushes. Sintered electrical contact materials are presently manufactured by Surahammars Bruks A. B., a company belonging to the ASEA group, well known among the international electrical industries.

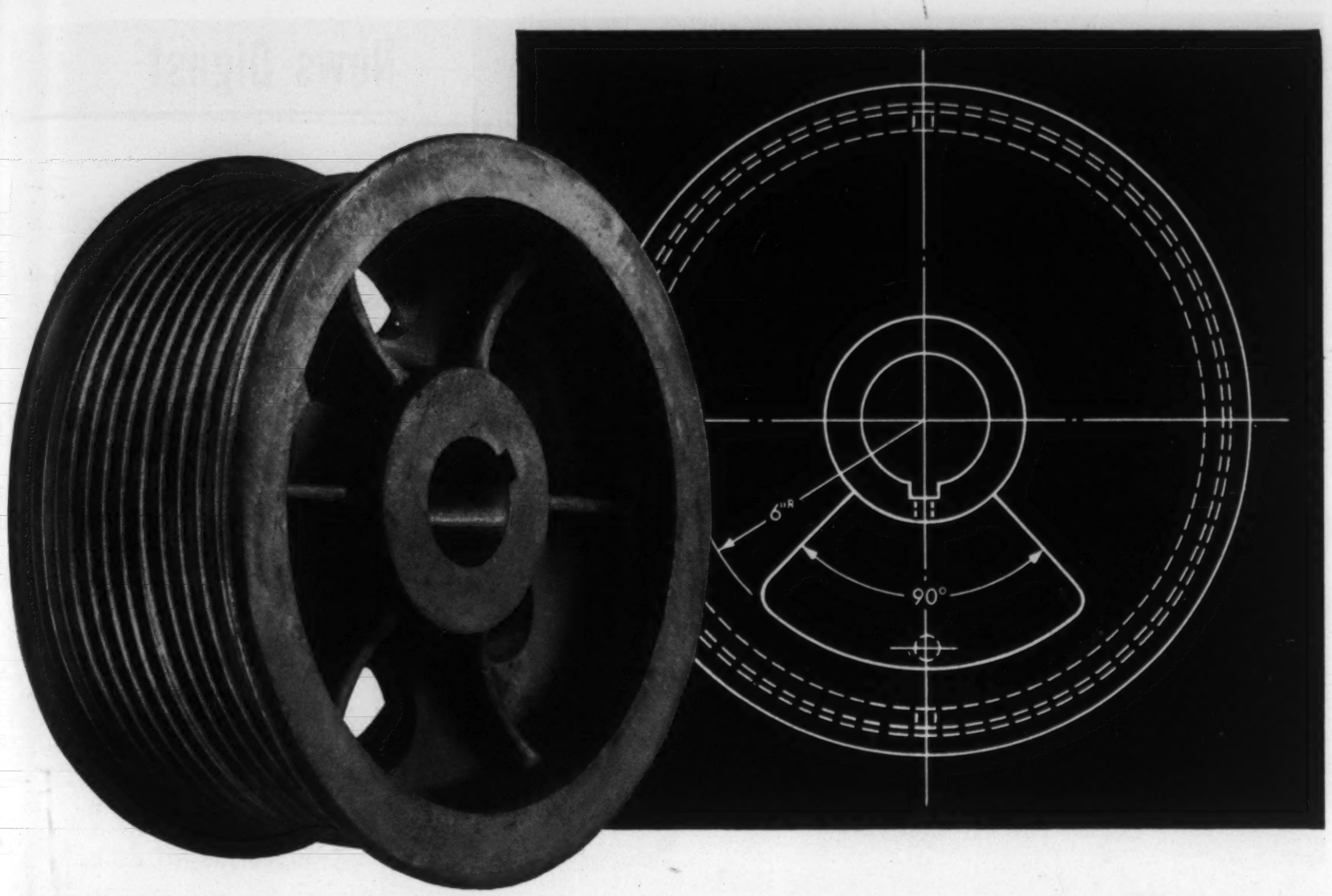
Companies such as Lamalampan A. B., Stockholm, and A. B. Kanthal, Hallstahammar, have international reputation and apply powder metallurgy for the manufacture of other products. Five factories for making sintered carbides produce tools of which a larger percentage is exported all over the world. Swedish sintered carbides are known to be outstanding for rock drilling purposes.

In a discussion concerning the difference between powder metallurgy production in the U.S.A. and Sweden, the chief engineer of Hoeganaes-Billesholms A. B., Sven I. Hulthen, pointed out that in Europe the most commonly used presses are comparatively simple, hand-operated mechanical presses, and only for pressures higher than 50 or 75 tons are simple hydraulic presses with one upper and one lower press punch used. To compact parts of intricate shape in the direction parallel to the compacting pressure it has, therefore, been necessary to build more complicated tools. The principle in most cases is that the die floats on springs.

He continued that "no strict rules have been accepted either for the manufacture or for the application of sintered parts. Some producers are trying to manufacture parts with high density and high mechanical characteristics at comparatively high prices, whereas others (and by far the majority) are trying to manufacture the parts as cheaply as possible, thus accepting the lower density values and lower mechanical characteristics caused by comparatively low pressing-pressures and sintering temperatures."

Until now, by far the most parts, especially in the U.S.A. have been produced in accordance with the last mentioned school of thought.

Both ways have advantages and disadvantages. It is considered, however, that for a long time to come, the way of making parts having low density and low mechanical characteristics will maintain its greater economical importance. It must not be forgotten, either, that it is essential



Costly to fabricate ECONOMICAL TO CAST IN GRAY IRON!

GRAY IRON Characteristics Include:

- Castability
- Rigidity
- Low Notch Sensitivity
- Wear Resistance
- Heat Resistance
- Corrosion Resistance
- Durability
- Vibration Absorption
- Machinability
- Wide Strength Range

The cable drum, shown above, was formerly produced by using plates of various thickness—cutting, assembling, welding and finally machining. Valuable and costly man-hours were expended in co-ordinating the efforts of the several mechanics involved in these operations. Thus, supervisory costs were added to high fabrication costs.

By redesigning the part as a Gray Iron casting, a cost saving of 41% per unit was effected. On a typical order involving 20 castings, the net saving to the customer was $197, *after* initial pattern cost had been written off. Note that grooves are *cast in* instead of machined, effecting a substantial saving in machining time.

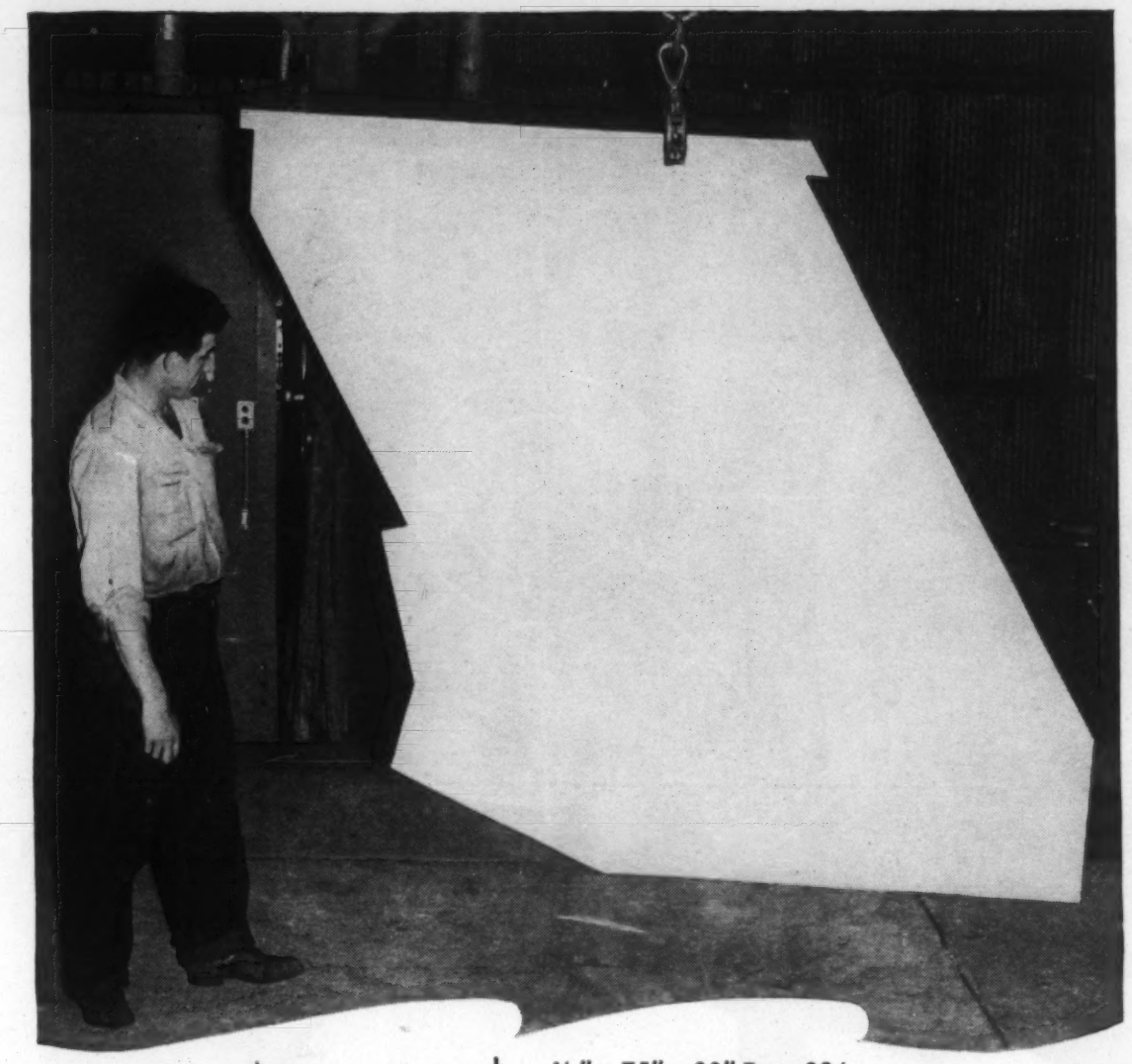
In addition to these savings, much longer operating life can be expected, because of Gray Iron's superior resistance to metal-to-metal wear and galling.

Don't miss opportunities like this to save man-hours, cut costs, and increase operating life by *redesigning in Gray Iron!* Write for technical information on advantages of the Gray Iron casting process.

Make it Better with Gray Iron • **Second largest industry in the Metal-working field**

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO



¼" x 75" x 88" Type 304

★

CARLSON STAINLESS PLATE

delivered cut to pattern

Not one, but 16 Type 304 irregular shapes as shown above were shipped recently to a leading fabricator.

Note the size, thickness, tolerance, and contour (size ¼" x 75" x 88" x irregular) —then judge for yourself the savings in time, labor, and convenience.

Such pattern cut plates are routine at G. O. Carlson, Inc. With our specially developed facilities, these large plates were abrasive cut and sawed at costs well below conventional methods—and our customer received the 16 pieces totalling 5263 lbs., ready for fabrication.

Whether you purchase full plates, square cuts, or pattern cut shapes—all G. O. Carlson, Inc. stainless plate is chemical quality. It pays to depend on our exceedingly large stock of all analyses, and our facilities for rough-finishing to your specifications. Inquiries and orders are given prompt attention.

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News Digest

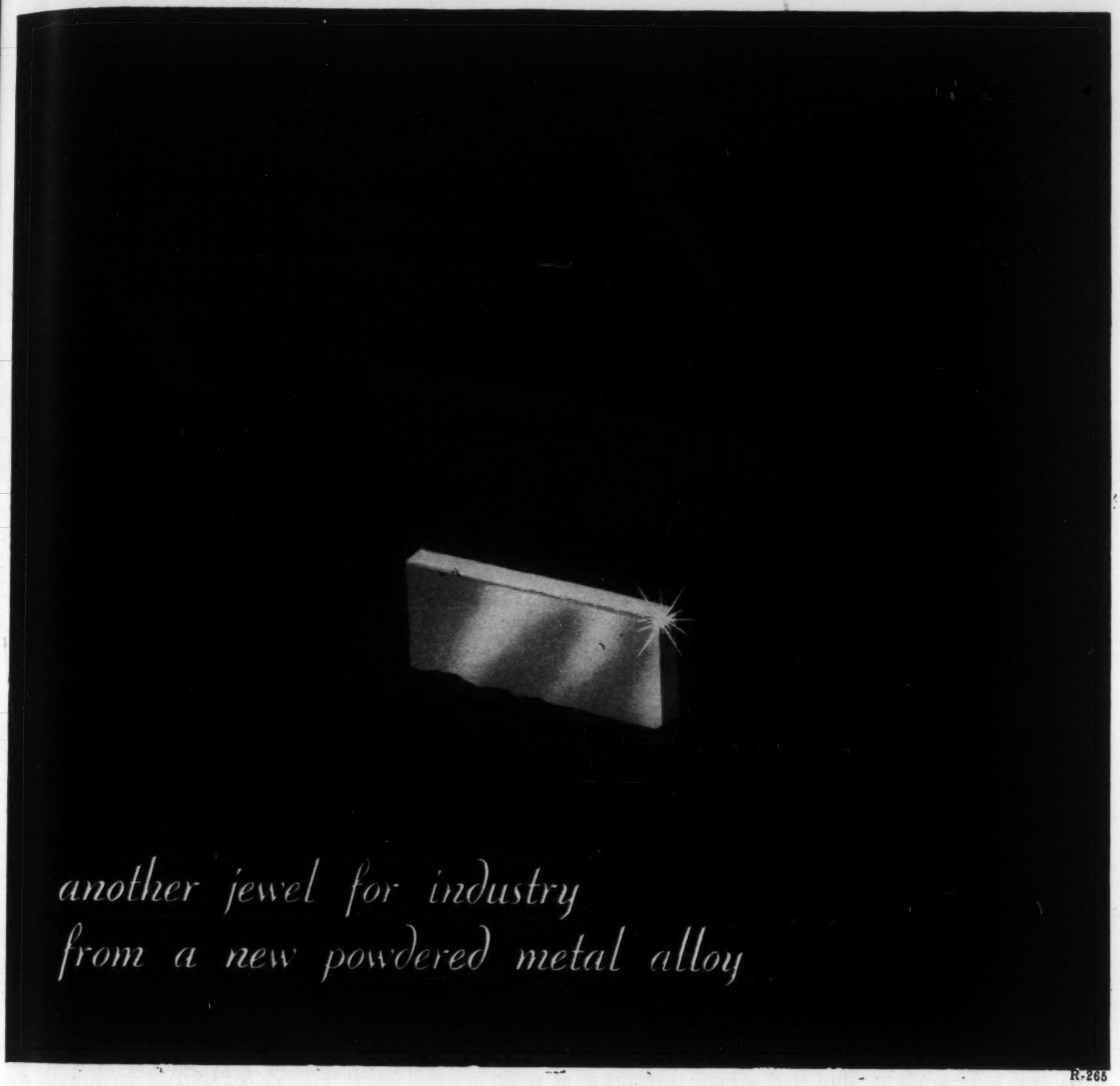
for the successful application of these kind of parts that the designers are well experienced in the use as well as the design of sintered parts. Otherwise, there is a great risk of failure, resulting in a bad name for powder metallurgy. In fact, this is what happened in Germany shortly after the war. The development of German powder metallurgy was so badly disturbed in this way that it is only during the last few years that German iron-base powder metallurgy seems slowly to be increasing again."

Aluminum Put to Good Use at Greenland Air Base

Aluminum panels are used in construction of the new Thule Air Force Base in northern Greenland, only 900 miles from the North Pole. They were designed to protect structures from the severe Arctic weather and keep in the buildings' heat.

The wall construction for these buildings actually comprises an aluminum sandwich. The wall is made up of an outer sheet of aluminum bonded to plywood and mounted framing. To this is attached an inner panel of plywood bonded to another sheet of aluminum which provides the inner surface of the wall. Fiber glass insulation is filled in the open space between the two plywood surfaces.

Very early in the planning of the top-secret Arctic air base, military authorities began experiments in the use of aluminum for construction of barracks and other buildings. The insulating properties of aluminum were probably the chief reason for the military's interest, in the opinion of Reynolds Metals Co., supplier of the metal. The problem was one of reverse refrigeration—how to keep out frigid temperatures (—60 F in winter) and keep in the heat necessary to maintain normal room temperatures for the comfort of Americans unaccustomed to Arctic weather. The lightness of aluminum was another attraction, because of transportation difficulties involved in getting materials and equipment to this far-



R-265

Firth Sterling Chromium Carbide For Gage Blocks

To meet exacting requirements, gage manufacturers are demanding Firth Sterling Chromium Carbide for the production of gage blocks. This new powdered metal alloy, Another First from Firth, embodies the following precise characteristics—

Write for Chromium Carbide Brochure

Chromium Carbide Gage Blocks

Light in Weight (Sp. gr. 6.97).
High Hardness (89 Rockwell A).
Corrosion Resistant (10 times stainless steel (18.8).
Expansion Coefficient (Similar to Steel).
High Polish (.15 micro-inches).

Firth Chromium Carbides are being appraised for application in many other industries where resistance to corrosion, heat and abrasion are required. Wide use seems imminent in the Glass, Ceramic, Chemical, Food, Textile, Pharmaceutical, Oil, Die Casting, and Machine Tool Industries.

From a powdered metal alloy, Firth Sterling presents another jewel to meet the demand for industry's modern requirements.

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Users of molybdenum are invited to consult Fansteel for assistance in design and the most economical fabrication. To the user, Fansteel fabrication eliminates the scrap and reject problem, minimizes inspection costs, and releases equipment and personnel for other work.

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News Digest

north base. And finally, the aluminum panels were found to be strong enough to withstand the 150-mile-per-hour winds which occur in that region.

New Standards Adopted for Thin Flat Metals

A 1952 revision of the American Standard, Preferred Thicknesses for Uncoated Thin Flat Metals (Under 0.250 in.), B32.1-1952, has been approved by the American Standards Association. It has been developed by ASA Committee B32, on Wire Diameters and Metal Thicknesses, jointly sponsored by the American Society of Mechanical Engineers and the Society of Automotive Engineers. Chairman of the committee is I. V. Williams, Bell Telephone Laboratories.

Twenty-five years ago, American industry in a general conference held by the ASA decided that it would be preferable to designate the diameters of wires, the thicknesses of metal sheets and plates, and the wall thicknesses of tubes by decimal fractions of an inch, rather than by the tradition gage numbers. A large number of gage number systems was found to be in existence, and the fact that a given number would designate different thicknesses, depending on the kind of metal, caused considerable confusion.

The ASA Committee B32 not only adopted in principle designation by decimal inches, but also developed the American Standard B32.1 covering the range of sheet metal thicknesses from 0.004 to 0.224 by values progressing in accordance with the 20-series of Preferred Numbers. That is, the step-up between two consecutive thicknesses was 6%.

The new American Standard differs from the 1941 edition in that the thicknesses are stepped up, from 0.004 to 0.236 in., in accordance with the 40-series of Preferred Numbers, or by 3%. Therefore, the designer has a wider choice of thick-

A New

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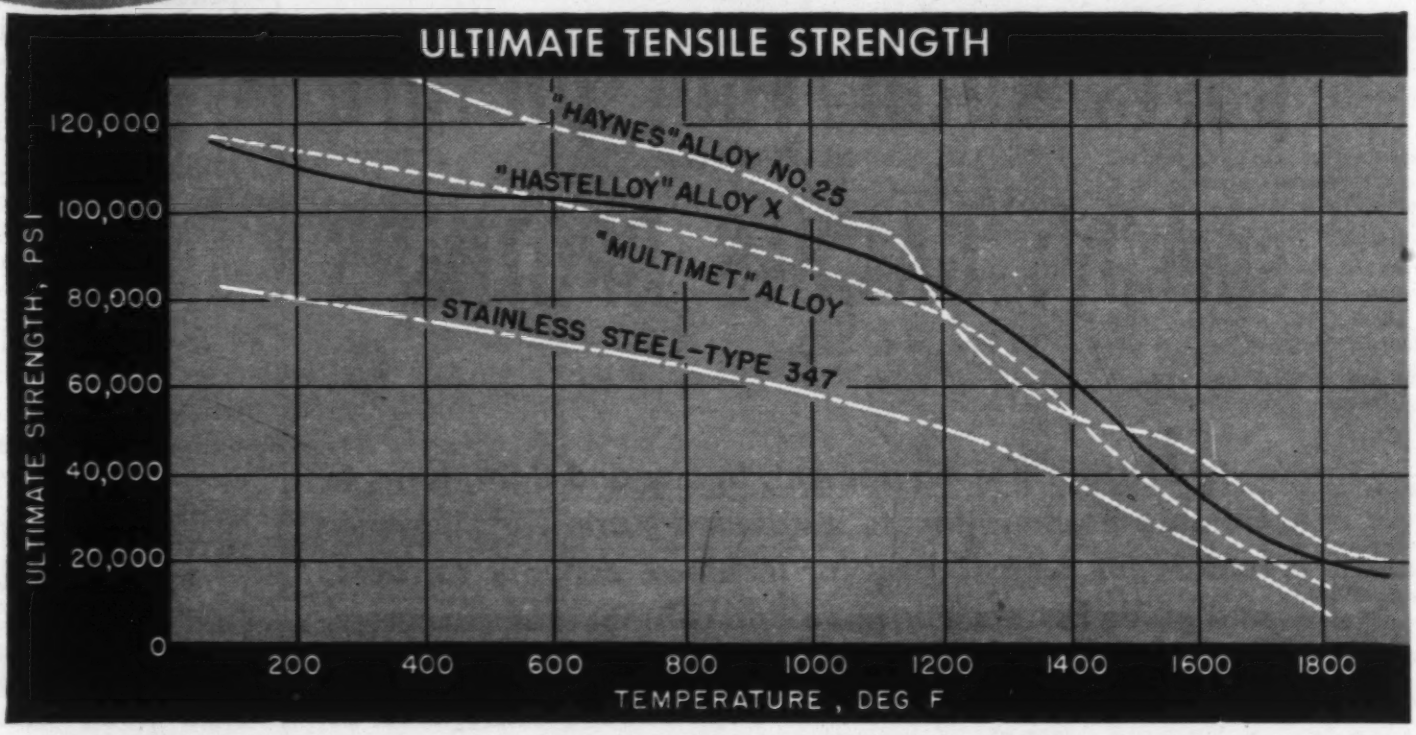

The excellent high-temperature properties of HASTELLOY alloy X—a new material that contains iron, nickel, chromium, and molybdenum—make this alloy a good choice for aircraft sheet-metal parts, such as cabin heaters, tail cones, and collector rings. It is also being tested for aircraft nozzle vanes, both precision-investment-cast and fabricated from sheet. In addition, it is designed for high-temperature applications in the chemical, petroleum, metal-producing, and heat-treating industries.

HASTELLOY alloy X has a relatively low content of strategic metals. Tests made so far indicate that alloy X has high-temperature properties comparable to those of other alloys containing a higher percentage of strategic metals (see graph).

The new alloy is available as sheet, plate, bars, wire, and precision-investment castings. For additional properties data, write to our General Offices in Kokomo, Indiana, for a copy of the new booklet "HASTELLOY Alloy X."

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nesses. Also, some of the values that have been added in the new standard are identical with, or close to thicknesses contained in the gage number systems. Thus, it will be easier for sheet metal designers who so far have used gage numbers to change to the 1952 American Standard, than it was for them to adopt the 1941 edition.

A basic advantage of the American Standard is that the recommended thicknesses apply to all sheets, independent of the kind of metal. This is important, particularly where products, such as sheet metal covers, first made of one kind of metal, have to be made of another metal—for example, due to priority regulations. The difficulties of substitution are minimized because the new products are dimensionally interchangeable with the original ones.

It is expected that the advantages of the new American Standard will cause it to be adopted more quickly in practice than has been the case with the 1941 edition. The main difficulty so far has been that warehouses have largely continued to stock sheet metal in accordance with gage numbers. Many users, not being able to purchase sheet metal with American Standard thicknesses from stock, were thus obliged to continue using products made to gage numbers.

Considerable impetus to the introduction of the original American Standard (1941) in practice has been given in recent years by the aircraft and telephone industries. It is hoped that this improvement will continue, even at a faster rate, now that a wider choice of American Standard thicknesses is available to the designer.

How Plating Variables Affect Properties of Electrodeposited Nickel

A much clearer picture of the effect of plating variables on the structure and properties of electrodeposited nickel has resulted from a comprehensive laboratory investiga-

VANCORAM PRODUCTS

PRODUCT	TYPICAL COMPOSITION	APPLICATIONS
ALUMINUM ALLOYS		
Alsifer	Aluminum ..... 20% Silicon ..... 40% Iron 40%	Used principally as a steel deoxidizer and for grain size control.
Deoxidizing Grades	Aluminum .... 85 to 99%	Standard grades.
Silicon Aluminum	Silicon ..... 5 to 20% Aluminum ..... Bal.	For sand, permanent mold and die casting.
Titanium Aluminum	Titanium .... 2½ and 5% Aluminum ..... Bal.	For grain refinement and improved physical properties of commercial aluminum alloys.
Vanadium Aluminum	Vanadium .. 2½, 5, 10% Aluminum ..... Bal.	For control of thermal expansion, electrical resistivity, and grain size of commercial aluminum.
BORON ALLOYS		
Ferro Boron	Boron ..... 14/18% Carbon ..... 1.50% Silicon ..... max. 5.00% Aluminum .. max. 0.10%	For adding boron to steels and irons.
Vanadium Grainal No. 1	Vanadium ..... 25.00% Aluminum ..... 10.00% Titanium ..... 15.00% Boron 0.20%	Practical and economical intensifiers, for controlling and increasing the capacity of steels to harden, and for improving other important engineering and physical properties.
Grainal No. 79	Aluminum ..... 13.00% Titanium ..... 20.00% Zirconium ..... 4.00% Manganese ..... 8.00% Boron ..... 0.50% Silicon 5.00%	
CHROMIUM ALLOYS		
Ferro Chromium Briquettes	Hexagonal. Weigh approx. 3⅜ lb., contain 2 lb. of chromium.	A practical and convenient form for adding ferro-chromium to the cupola.
High Carbon Grade	Chromium ..... 66/70% Carbon 4/6%	For wrought constructional steels and steel and iron castings.
Iron Foundry Grade	Chromium ..... 62/66% Carbon ..... 4/6% Silicon 6/9%	For alloyed cast irons. Ladle addition readily soluble at lower temperatures of cast iron.
Low Carbon Grades	Chromium ..... 67/72% Carbon .... .06%, .10%, .15%, .20%, .50%, 1.00% and 2.00% max.	For low carbon chromium steels, especially those with high chromium content, such as stainless steels and heat-resistant types.
Low Carbon Ferrochrome-Silicon	Chromium ..... 39/42% Silicon ..... 40/42% Carbon .... max. 0.05%	Used in stainless steels to reduce chromium oxide from slag and to add chromium to steel.
Experimental Ferrochrome-Silicon Alloy	Chromium ..... 48/52% Silicon ..... 25/30% Carbon ..... max. 1.50%	For simultaneous addition of chromium and silicon to low alloy steels and cast iron.
SILICON ALLOYS		
Ferro Silicon Briquettes	Two sizes, both cylindrical. The smaller contains 1 lb. of silicon; the larger, 2 lbs. of silicon.	A practical and convenient form for adding ferro-silicon to the cupola.
25/30% Grade	Silicon 25/30%	To deoxidize open hearth steels and add silicon to cast iron.
50% Grade	Silicon 47/52%	To deoxidize and add silicon to steels and cast irons.
75% Grade	Silicon 74/79%	For high content silicon steels.
80/85% Grade	Silicon 80/84.9%	For high silicon addition to steel; for slag treatment and graphitization of iron; for making magnesium.
85/90% Grade	Silicon 85/89.9%	
90/95% Grade	Silicon 90/95%	
Silicon Metal	Silicon ..... min. 96%	For making aluminum, other nonferrous alloys and silicones.

PRODUCT	TYPICAL COMPOSITION	APPLICATIONS
SPECIAL FOUNDRY ALLOYS		
Graphidox No. 4	Silicon ..... 48/52% Titanium ..... 9/11% Calcium 5/7%	Graphitizer for high strength cast irons; reduces chill; supplementary deoxidizer for cast steel.
Noduloy No. 12	Magnesium .. 10.5/13% Copper ..... 15/18% Silicon ..... 37/41% Iron ..... Bal.	Magnesium-containing alloys for addition to molten cast iron for manufacture of ductile (nodular) iron.
Noduloy No. 3	Magnesium 13.5/16.5% Silicon ..... 62/67% Iron ..... Bal.	
V-5 Foundry Alloy	Chromium ..... 38/42% Silicon ..... 17/19% Manganese 8/11%	To reduce chill and increase strength and hardness of cast iron.
TITANIUM ALLOYS		
Ferro Titanium High Carbon Grade	Titanium ..... 15/18% Carbon 6/8%	To control rimming action and deoxidize steel.
Medium Carbon Grade	Titanium ..... 17/21% Carbon 3/4.50%	To deoxidize and to add titanium to killed steels.
Low Carbon Grades 25% Titanium	Titanium ..... 20/25% Carbon .... max. 0.10% Silicon ..... max. 4.00% Aluminum .. max. 3.50%	Carbide stabilizer in high chromium corrosion-resistant steels of extremely low aluminum content. Deoxidizer for some steels.
25/32% Titanium Special	Titanium ..... 25/32% Carbon .... max. 0.10% Silicon ..... max. 4.00% Aluminum .. max. 2.00%	Alloy of high titanium-to-aluminum ratio for adding relatively large amounts of titanium to stainless and heat-resistant steels.
40% Titanium	Titanium ..... 38/43% Carbon .... max. 0.10% Silicon ..... max. 4.00% Aluminum .. max. 8.00%	Carbide stabilizer in high chromium corrosion-resistant steels.
VANADIUM ALLOYS		
Ferro Vanadium Iron Foundry Grade	Vanadium ..... 38/42% Silicon ..... 7/11% Carbon ..... about 1%	Imparts remarkable improvement in physical properties of iron with no sacrifice of machinability.
Grade A (Open Hearth)	Vanadium ..... 50/55% Silicon ..... max. 7.50% Carbon ..... max. 3.00%	For low vanadium steels and vanadium cast irons.
Grade B (Crucible)	Vanadium ..... 50/55% Silicon .... max. 3.50% Carbon ..... max. 0.50%	For tool steels and other high vanadium steels requiring a limited silicon addition.
Grade C (Primos)	Vanadium ..... 50/55% 70/80% Silicon ..... max. 1.25% Carbon ..... max. 0.20%	For making the highest vanadium and the lowest silicon addition to tool steels.
Vanadium Metal 90% Grade	Vanadium ..... 91.15% Aluminum ..... 2.25% Silicon ..... 0.50% Carbon 0.17%	For special iron-free (non-ferrous) or low iron alloys or low impurity ferrous alloys.
95% Grade	Vanadium ..... 95.18% Aluminum ..... 2.00% Silicon ..... 0.27% Carbon 0.40%	Principally for research on the properties of pure alloys. For use in applications where very low iron content is essential.
Vanadium Pentoxide, Tech. Fused Form	V_2O_5 ..... 88/92%	A source of vanadium in basic electric furnace steels. A base for numerous chemical compounds.
Air-Dried Form	V_2O_5 ..... 83/85%	Base for chemical compounds.
Ammonium Meta Vanadate, Tech.	NH_4VO_3 ..... min. 99%	For making sulphuric acid, synthetic organic compounds and vanadium chemicals.

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News Digest

tion conducted over the past five years by Victor Zentner, Abner Brenner and Charles Jennings of the National Bureau of Standards. In the course of the study, which was sponsored by the American Electroplaters' Society, cathode current efficiencies and the internal stress of the deposits were determined for a great number of different bath compositions and operating conditions, the chemical composition and microstructure of the deposits were investigated, and their thermal and mechanical properties were measured.

The results show that hardness, tensile strength, and other properties of nickel deposits can be varied over a wide range by proper choice of plating bath. Moreover, it has been possible to explain this broad variation in properties on the basis of the physical nature of codeposited impurities present in small amounts.

Industrial use of nickel plating includes a variety of applications. In general, the thinner coatings are used for ornamental purposes or for protection against corrosion while the heavier deposits are applied to machine parts, where resistance to wear is an important factor, and used in electroforming. Although quite different properties are required in different applications, until now little information has been available regarding the relationship between the conditions under which the plating is done and the resulting deposit. The NBS investigation provides a large amount of basic data which can now be utilized for the consistent production of deposits having desired properties. While major emphasis was placed on those mechanical properties of the deposits which are of immediate value in engineering applications, data were also collected on electrical and other properties which may be of value in determining the suitability of nickel deposits for special applications.

It was found that the most important factor affecting the properties of the deposits is the type of plating solution, that is, the nature of the anion and the presence of special additives. Although deposits produced at lower temperatures were usually finer-grained than those obtained at high temperatures, the effects of variations in operating conditions, such as temperature and current density, are in general relatively

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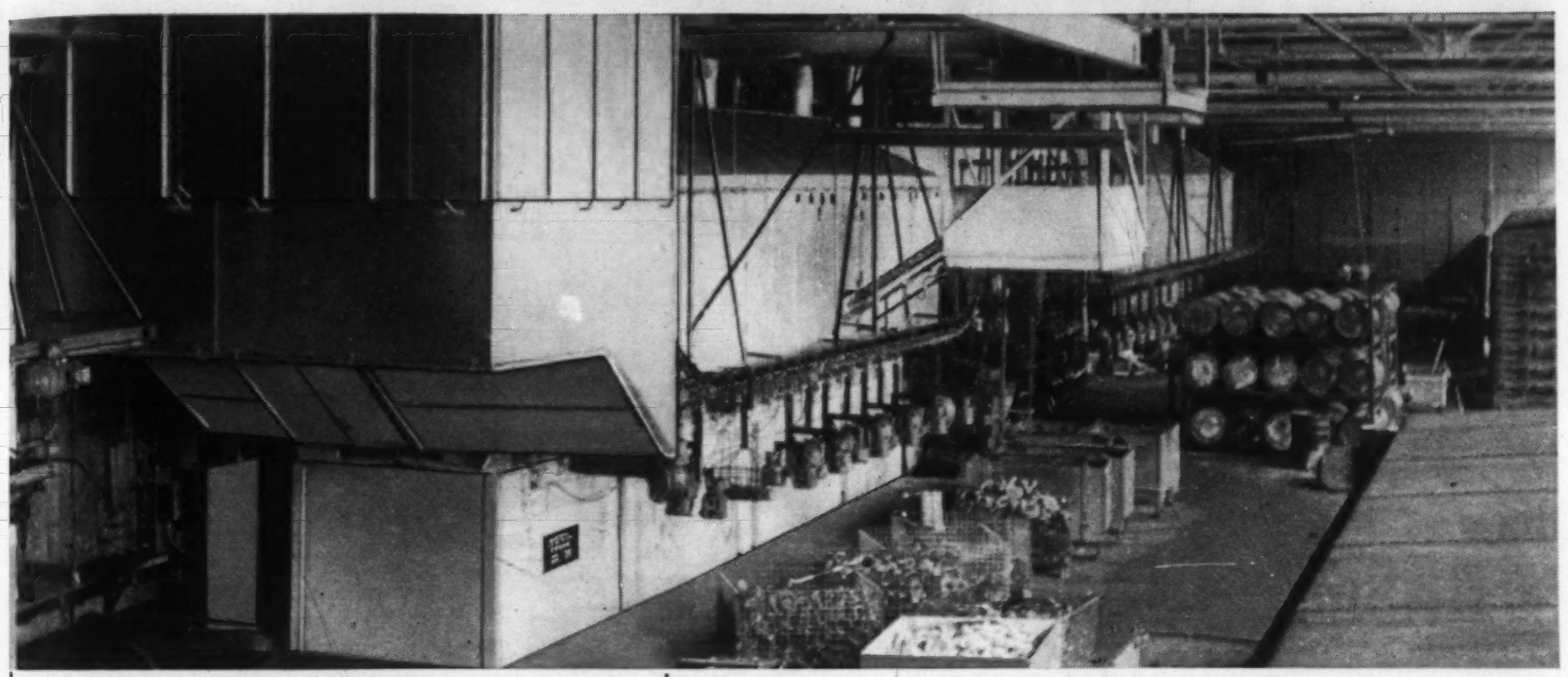
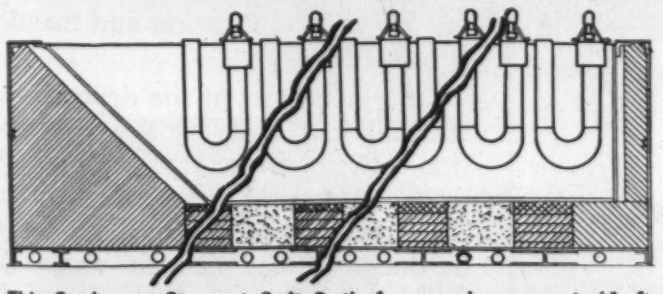


PLAN VIEW— ANNEALING, DESANDING AND DESCALING INSTALLATION



This Sunbeam Stewart Salt Bath furnace has a pot 41 ft. long by 4 ft. wide by 4 ft. deep. Forty U-shaped immersion heating tubes, each equipped with a pressure burner of the flame retention type having an individual pilot burner, provide the necessary heat and control for maintaining the bath at proper working temperature. Burners are arranged in three temperature control zones extending the length of the furnace to assure uniform heating throughout the entire length of the bath.

To economically prepare automotive housings for final fabrication, one large manufacturer of automotive equipment required a molten caustic bath capable of descaling, dissolving all embedded foundry sands, while providing a stress relieving and softening annealing cycle. By combining these operations into one completely automatic unit, it was possible to eliminate separate installations, overcome additional handling costs and also reduce floor area.

Handling of castings is completely automatic from the loading of as-received work from box-cars through the entire process. Time and cycle is approximately 4½ minutes in the salt. Temperature is usually between 1100° and 1200°F., depending upon the characteristic of the work.

Although this particular installation is used primarily for castings, this equipment will successfully handle forgings, hot headed bolts, wire and wire products, etc., where scale must be removed before the product is completed. This design is available covering practically all types and sizes of work in both the continuous and batch type systems.

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small, provided the conditions are within the satisfactory operating range for the solution used.

On the basis of the physical and mechanical properties of the deposits, nickel plating baths may be classified in three main groups: bright-nickel baths, containing organic brighteners; high-chloride baths, containing more than 50% of the nickel present as chloride; and Watts-type baths, which contain the nickel in the form of both sulfate and chloride in the ratio of 3:1. In general, the extremes in properties are shown by the bright-nickel and the Watts-nickel deposits, while the properties of the high-chloride nickel are intermediate between the two. The bright-nickel baths yield bright deposits having the greatest hardness, tensile strength, resistivity and coercive force of all types of nickel deposits, but they also have the lowest ductility, elongation and magnetic permeability. The high-chloride baths, on the other hand, produce dull deposits which are somewhat below bright nickel in hardness and tensile strength but have a higher ductility. From the Watts-type baths are obtained dull grey deposits. These are the purest of the three types; they possess the lowest stress, hardness, tensile strength, resistivity and coercive force and, at the same time, the highest ductility, elongation and magnetic permeability.

The properties of the deposits were affected very little by the concentration of nickel in the plating solutions. However, the effect of the chloride content of the bath on the hardness of the deposit was rather striking. When a bath containing one-fourth of the nickel in the form of chloride and the rest as sulfate was used, a pronounced minimum in hardness of the deposit was observed. As yet, no explanation for this effect has been developed.

In its influence on the mechanical properties of the deposits, the pH of the plating solution was second in importance only to the nature of the bath constituents. In the pH measurements, it was found that when the pH of the bath goes above 5, the tensile strength of the deposit rapidly rises and the ductility decreases. If the pH of the solution is made high enough, there is a marked increase in hardness and tensile strength and a decrease in elongation. However,

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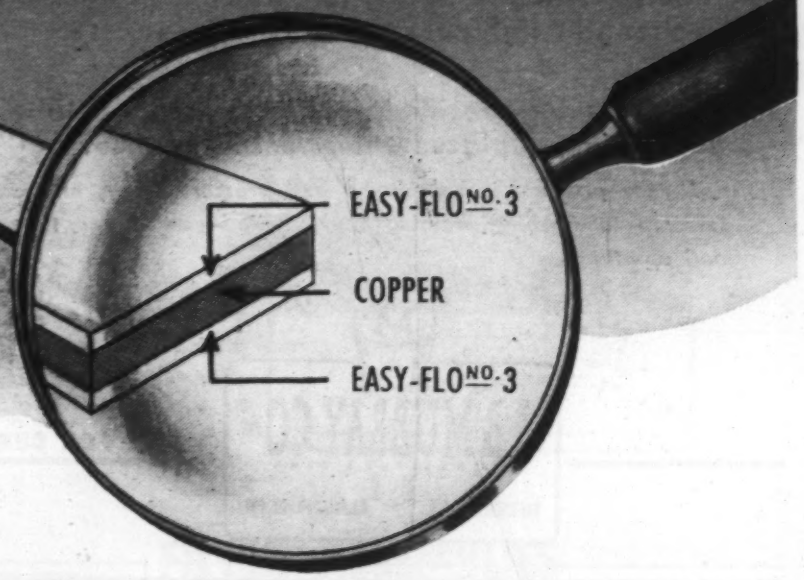
EASY-FLO No. 3 TRIMETAL

tops for brazing carbide tool tips for *heavy duty-high heat* cutting

Mounting carbide tips is a cinch when you use EASY-FLO No. 3 TRIMETAL. After cleaning tips and tool surfaces, use a precut shim, or cut shims to fit, preplace them and heat. Anybody can be readily trained to do it. Illustrations show work of this kind being done at the Modern Corporation, Detroit, Michigan.



WHAT IT IS An EASY-FLO No. 3 coating on each side of a copper shim – in a 50/50 ratio of alloy and copper. Flow point is 1270°F. EASY-FLO No. 3 is the silver brazing alloy that has long been favored for mounting cemented carbide tips and recommended by leading tip manufacturers.

WHAT IT'S FOR – It's the fast, easy, low-cost way to mount cemented carbides for applications calling for a "sandwich" type braze such as big lathe, planer and shaper tools, milling and form cutters, broaches, etc. Preplacing the alloy and copper all in one piece instead of three, saves a lot of time and labor.

WHY IT EXCELS – The EASY-FLO No. 3 makes its usual high strength joints while the copper acts as a shock absorber and heat distributor. The combination assures joints capable of withstanding the big stresses and high heat of heavy duty cutting – amply proved on actual rock drill bits and on big milling cutters as shown at left.

FORMS AVAILABLE – STRIP from ¼" to 2" wide, and SHEET from 2" to 4". Overall thicknesses of .010", .015" and .020" and heavier. Also in precut shims to fit standard carbide tip sizes.

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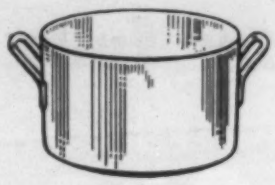

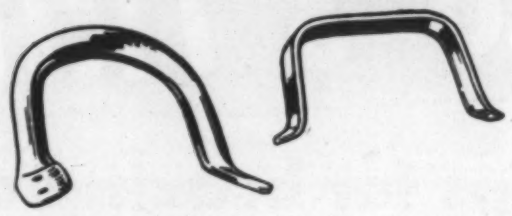

Handles for cooking pots, once made from stainless strip, now are made from stainless tubing. No edges meet inside the handle. A smooth solid surface, more sanitary, easier to clean, and more appealing in appearance is the result. Rejections are less than 5%.

Where appearance counts, stainless is a must. When a tubular form will do the job, you also gain other advantages —strength, lightness, easy formability, economical machining.

Ask us for specific information on any tubular problem— production, replacement or maintenance.

Murray products include boiler and pressure tubes, mechanical tubing, stainless pipe and tubing, welding- and screwed-type fittings, tube bending, swaging, and upsetting.

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Two or more parts made as one
Cut machining operations

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DOLLIN CORPORATION 610 So. 21st St., Irvington, N. J.

these extreme properties are accompanied by such a great increase in stress that the deposits are likely to crack spontaneously or exfoliate.

The microstructure of the deposits was rather closely correlated with their observed properties. Thus, in micrographs of nickel deposits from baths of varying chloride content, the most coarse-grained deposit had the lowest hardness. In general, deposits with coarse-grained structures contained relatively small amounts of impurities and were soft, ductile and low in tensile strength. On the other hand, deposits with either fine-grained structures or no visible grain structures contained a relatively large amount of impurities and were strong and hard but not very ductile.

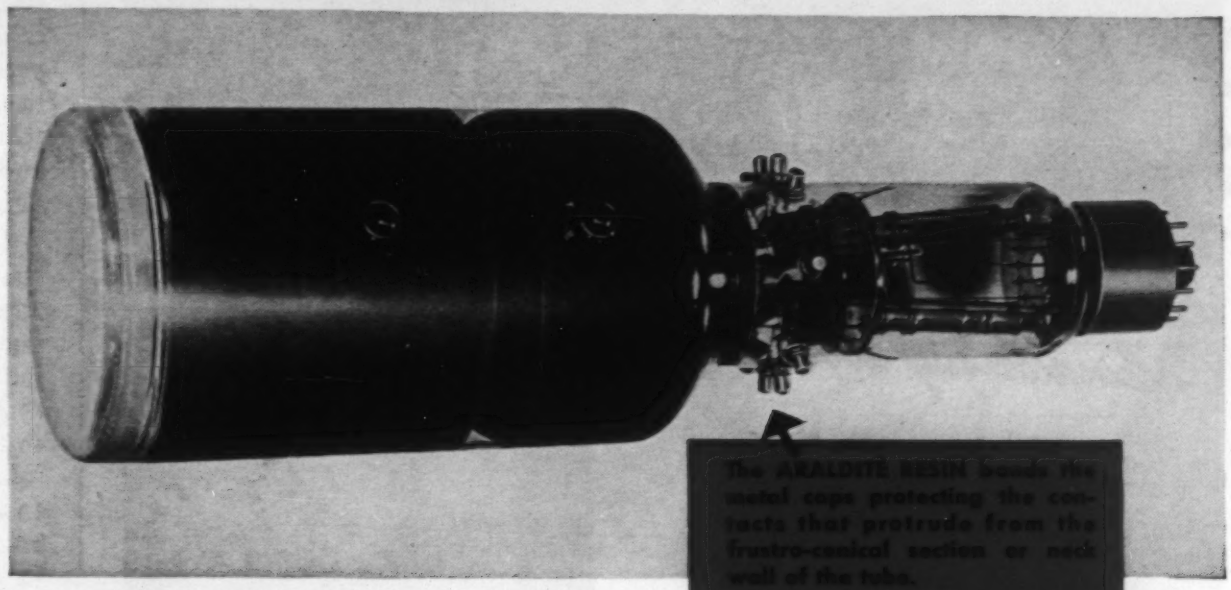
Heat treatment was found to have a much more pronounced effect on the mechanical properties of bright nickel than on those of Watts nickel. Thus, after heat treatment at 750 F, the tensile strength of bright nickel fell from about 200,000 to about 20,000 psi. By contrast, the tensile strength of Watts nickel decreased by only 15,000 psi from an initial value of 75,000 psi. A comparison of the microstructures of the two types of deposits shows large clean grains in the Watts nickel while the bright nickel deposits have dark areas which may indicate either inclusions or voids.

On the basis of the data obtained in the investigation, it appears that the widely varying properties shown by electrodeposited nickel are determined primarily by the chemical and physical nature of codeposited impurities—usually small quantities of oxygen, hydrogen, carbon or other elements present in small fractions of a percent. This is shown not only by the parellel trend in the variation of many of the properties, indicating a common basic cause, but also in the correlations found between properties and crystal or microstructure and in the pronounced dependence of the properties on bath composition. Because large changes in the deposits result from the presence of certain types of ions or minute amounts of special additions to the plating bath, it is reasonable to assume that the distinctive character of the deposits is caused by the codeposition of various kinds of foreign matter which may vary in quantity as well as in effectiveness. The codeposited mate-

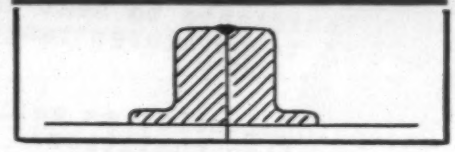
IDEAS *in the making*

Araldite* Bonding and Casting Resins developed by Ciba Research are simplifying manufacturing methods, improving product efficiency, and opening new fields of product development. You will want to know more about them.

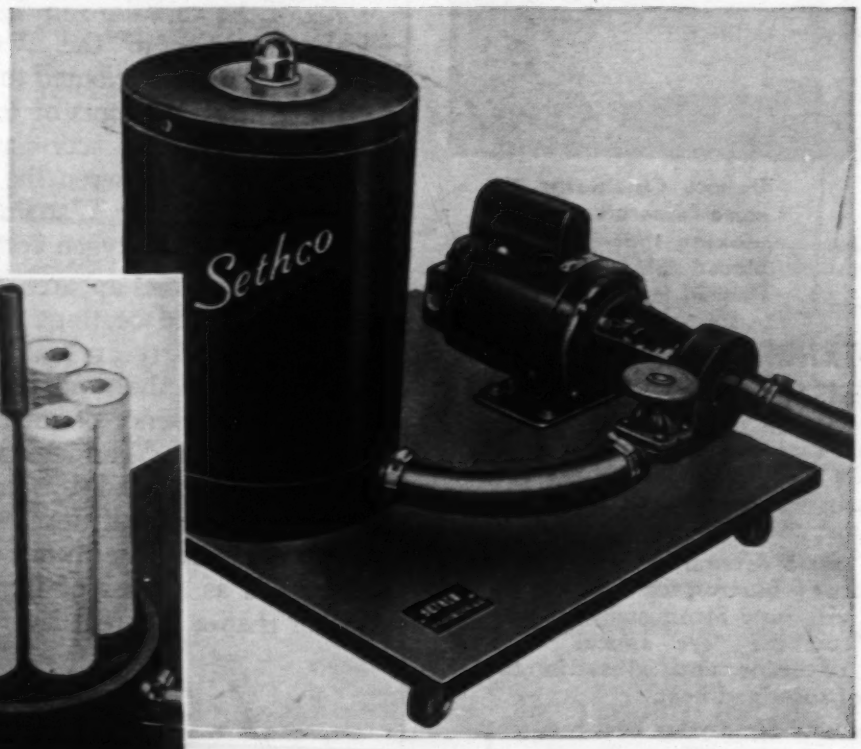
DURABLE . . . HIGH TEMPERATURE RESISTANT METAL-TO-GLASS BOND ON CONTACT LEADS ON DUAL-BEAM CATHODE RAY TUBE



The ARALDITE RESIN bonds the metal caps protecting the contacts that protrude from the frustro-conical section or neck wall of the tube.
(Photo courtesy Allen B. Du Mont



The exceptional bonding properties of ARALDITE RESINS whereby durable bonds are achieved between many different types of materials under severe service conditions where other bonding materials prove inadequate, are demonstrated in this important application by the Allen B. Du Mont Laboratories, Inc. The ARALDITE RESIN used, "has proven very satisfactory in its bonding strength and in its resistance to softening under conditions of high humidity at elevated temperatures."



FILTER ASSEMBLIES FOR PUMP UNITS THAT ARE HIGHLY RESISTANT TO ALL TYPES OF CHEMICAL SOLUTIONS

The filter cylinders shown in the inset are ARALDITE RESINS cast in specially designed molds to provide permanent units within complete filter equipment capable of pumping as much as 2280 gallons per hour of highly corrosive solutions . . . a primarily important factor in the use of Sethco Filter Pump Units such as the model shown here for durably efficient installations in process equipment.

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Sicon in colors withstands 500°F.

SICON, THE ORIGINAL SILICONE HEAT-RESISTANT FINISH, IN GLEAMING WHITE AND TAN PROTECTS SURFACE OF HOME INCINERATOR

Here's what the makers of Calcinator say about **SICON**

"In keeping with the high standards we wished to attain for Calcinator, we chose 'Sicon.

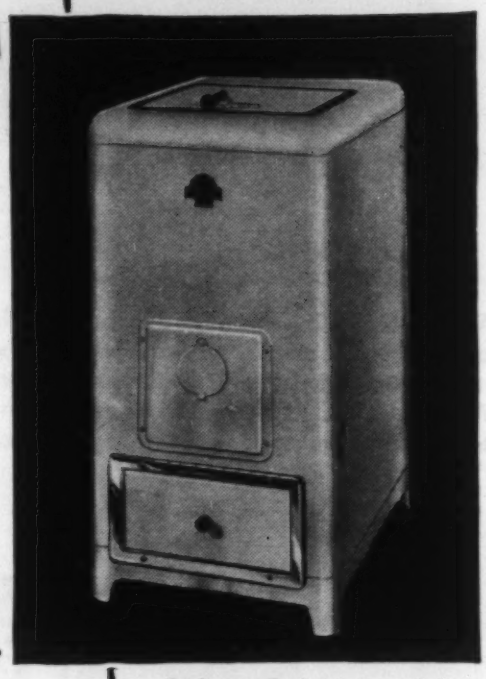
Under rigid perfection tests 'Sicon' was found to have:

1. High resistance to heat when exposed to temperatures ranging from 400 to 500°F.

2. Exceptional color as well as gloss retention qualities.

In addition, only 'Sicon' had good inherent qualities of adhesion and film stability."

W.M. Milbourne, Sales Mgr., Calcinator Division Valley Welding & Boiler Co., Bay City, Michigan



Deluxe Calcinator, the home incinerator so smart looking that it can be placed right in the kitchen. Finished in SICON White.

Standard Calcinator, for utility room or basement location, features latest advances in incinerators. Finished in SICON Tan.

SICON STANDS UP WHERE OTHER HEAT-RESISTANT FINISHES FAIL!

In case after case, for product after product, SICON has proved to be the *only* heat-resistant finish to pass all tests—in the laboratory and on the production line.

Sicon, in smart decorative colors, now opens up a new horizon for design engineers, because only Sicon makes it possible to combine "eye appeal" with retention of color and gloss in the presence of sustained heat.

No matter how rigid your heat-resistant finish requirement, *try* Sicon, the original silicone-base finish that has revolutionized product finishing wherever high temperatures pose a problem.

Write for brochure and complete engineering details.

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News Digest

rial may sometimes influence the properties of the deposit directly; in other cases, it may result in a fine-grained structure, perhaps with lattice distortion and internal stresses, which, in turn, affects the physical and mechanical properties of the deposits.

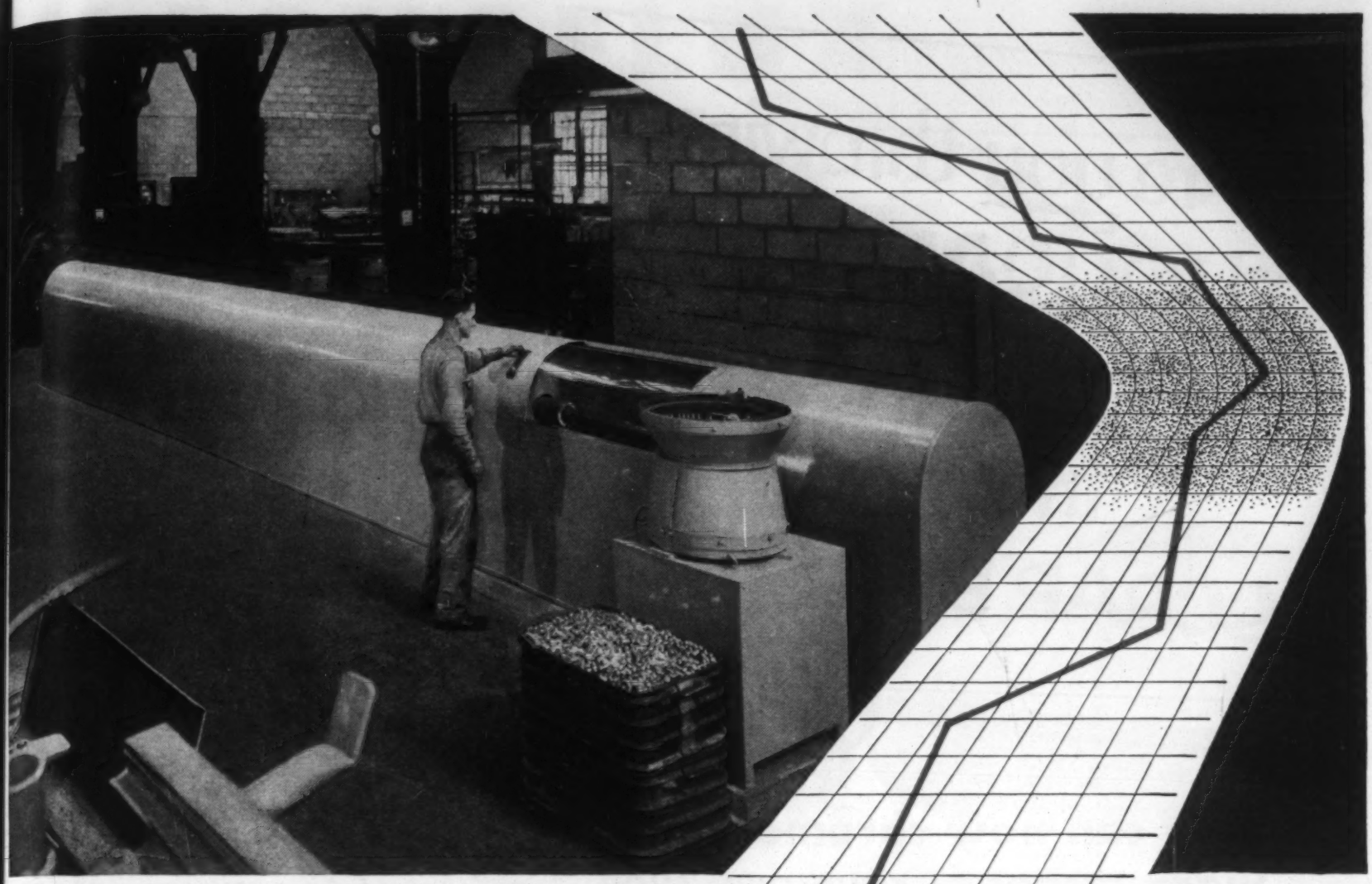
In general, it would seem that substances present in the plating solution affect the properties of the electrodeposit only to the extent that they influence the codeposition of foreign material. Thus, the great differences in the properties of bright-nickel and Watts-nickel deposits can be ascribed to impurities in the bright nickel derived from the organic additives used to produce the brightening. In fact, the Bureau's analysis of the bright-nickel deposits showed that they contained carbon and sulfur inclusions totalling about 0.1%, whereas the Watts-nickel deposits did not contain these impurities. On the other hand, some of the variations in the mechanical properties of the Watts-nickel deposits can be attributed to the presence of small amounts of oxide. For example, a good correlation was found to exist between the mechanical properties of Watts-nickel deposits and their oxygen content.

It thus becomes apparent that those electrodeposited coatings that are of value in industry are not pure coatings, but owe their valuable properties to the presence of small amounts of impurities. The smooth, thick electrodeposits used by the plating industry are actually exceptional inasmuch as the pure metals would be deposited as a mass of large crystals rather than a coherent layer.

Chrysler Corp. Plans Materials Laboratory

One of the most complete production control metallurgical laboratories in the nation will be established by the Chrysler Corp. at its Dodge plant in San Leandro, Calif., to insure and improve the quality of airplane propellers which will be manufactured there.

Employing a wide variety of laboratory instruments—x-ray machines,



An automatic heat treat machine. Production is about 3 times that possible with manual methods while quality is held within very close limits.

CRUCIBLE ALNICO MAGNETS

KEEP COSTS DOWN . . . *through automatic production that gives quality control*

Alnico magnets have been getting smaller and lighter, thanks to production techniques in use at Crucible. Automatic machinery cuts the possibility of human error to a minimum, so rejections are low. This helps to maintain stable price levels in the face of rising material and labor costs. At the same time, Crucible's rigid inspection standards and attention to quality have developed a magnet with the *highest gap flux per unit weight of any on the market.*

Today, Crucible can offer lighter, magnetically stronger Alnico magnets because of these automatic production techniques developed over the sixteen years that we have been producing the Alnico alloys. And behind our familiarity with permanent magnets lies more than 52 years' experience with specialty steelmaking. Let us advise you on your magnet problem.

CRUCIBLE first name in special purpose steels

52 *years of* Fine *steelmaking*

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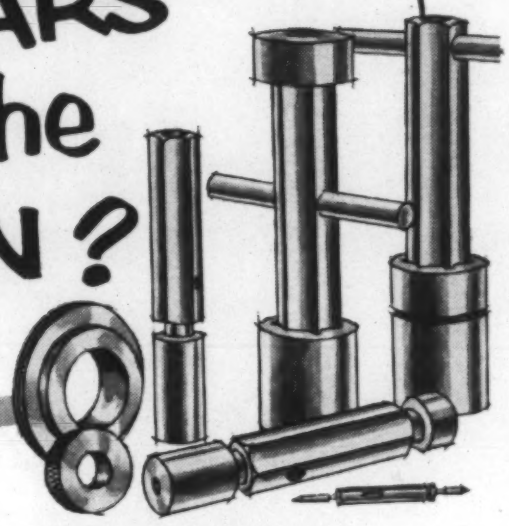
Are you throwing THOUSANDS OF DOLLARS into the SCRAP BIN?



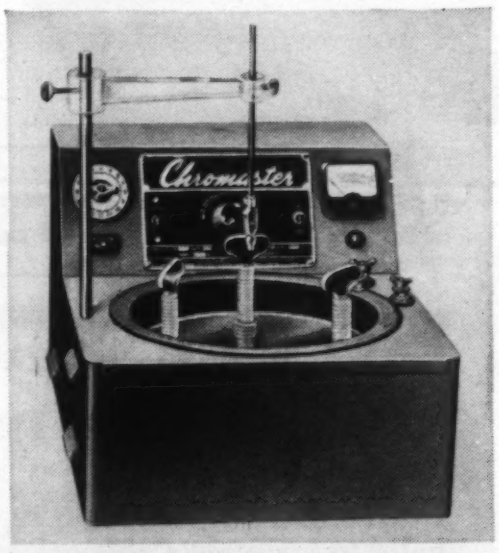
You can now chrome plate worn gages *IN YOUR OWN SHOP*

This compact new chrome plating unit is saving real money for leading engineering and manufacturing concerns throughout the country. For instance, here's what Taller and Cooper, Inc., foremost makers of toll collection equipment and builders of electromechanical measuring and recording devices, say about their Chromaster installation:

> "Within one hour from the time a space was arranged for the unit, the Chromaster was in operation. In the very first day over $100.00 worth of undersize plug gages that normally would have been discarded were replated and put back in use in our inspection department."

Same saving applies to other small tools

Normal life of your cutting tools and wear parts can be multiplied 3 to 10 times by this accurate, simplified method of chrome plating right in your own shop. Chromaster deposits chrome with positive uniformity yet the average job takes only 3½ minutes.



A Chromaster for every shop

Model A-20 (shown here) is a 20-amp, bench-mounted unit for the gage room or tool crib; plates up to 10 sq. in.

Model A-50, 50-amp, bench-mounted unit for larger shops in plating of cutting tools. Plates up to 25 sq. in.

Model A-250, 250-amp, floor-mounted unit for production plating of small parts in greater quantities or larger parts with areas up to 125 sq. in.

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News Digest

spectrographic equipment, cold cabinets and other testing apparatus—the laboratory staff will keep a check on the quality of propeller production from raw materials to final assembly.

"One important part of the laboratory program," Mr. Newberg, president of Dodge Div., said, "will cover packaging of the finished product so that propellers shipped to the Arctic or to humid tropical climates will be safeguarded against the effects of extreme climates."

Although the laboratory will be primarily a metallurgical one, it will also be equipped to analyze and test other materials, particularly rubber, which is vulcanized into the Hamilton Standard propeller's inner cavity to give it strength.

Divisions of the laboratory will include three darkrooms; a metallographic preparation room where metals are sliced for cross-sectional photographic analysis of their structure; salt spray, cold and humidity cabinets to test effectiveness of packaging; a complete spectrographic section, principally for metal analyses; a chemical laboratory; a heat treating room; and electrical testing. The laboratory's x-ray facilities will be located adjacent to the propeller production line.

New Study Shows Domestic Graphite Satisfactory for Crucibles

A recent investigation by the National Bureau of Standards indicates that, for making the crucibles used in nonferrous foundries, domestic graphites from Alabama and Pennsylvania are fully as good as the traditional imported Madagascar graphite. Furthermore, it appears from the NBS study that small-flake graphite can be used instead of the generally preferred large-flake graphite without impairing the service life of carbon-bonded graphite crucibles. The NBS work also indicates that the carbon-bonded type of crucible has about twice the average service life of the clay-bonded type. The study was conducted by R. A.

MAGNAFLUX

THE PIONEER IN NON DESTRUCTIVE TESTING

Now Announces Spotcheck

a simple SPRAY-ON DYE PENETRANT inspection

END GUESSWORK ARGUMENTS!

Use it to Locate and Mark Defects Open to the Surface in Metals—Carbides—Plastics —Ceramics—Practically any Non-Porous Solid

Spotcheck crack indication revealed in inspection of local area of punch press frame.

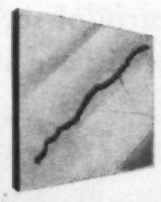
How Spotcheck shows up non-visible crack in carbide tool. Correct grinding! Avoid failure after set-up!

Spotcheck is a new, *lowest cost* inspection tool for use where remote location, small surface areas, limited volume or the cost of disassembling equipment makes use of fixed inspection equipment impractical. The complete kit is as easy to carry as a dinner pail!

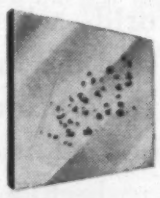
A new member of the world's best known Magnaflux family of inspection methods, Spotcheck finds and indicates cracks, porosity, laps, seams, etc., clearly and unmistakably. It takes the guesswork out of countless sampling inspection jobs.

Used for *maintenance inspection,* local and routine Spotcheck tests will help you to prevent costly on-the-job failure of production machines. SPOTCHECK IS IDEAL FOR INSPECTION OF CARBIDE TOOLS AND OTHER TOOL CRIB USE!

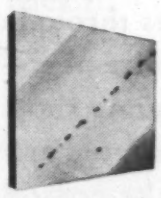
SPOTCHECK INDICATIONS



CRACK, cold shut or similar opening



PITS OR POROSITY



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Complete Spotcheck Kit No. SK-1

8 12-oz. cans; 4 of Cleaner, 2 each of Penetrant and Developer, together with carrying case, plus instructions and accessories.

LOW IN FIRST COST

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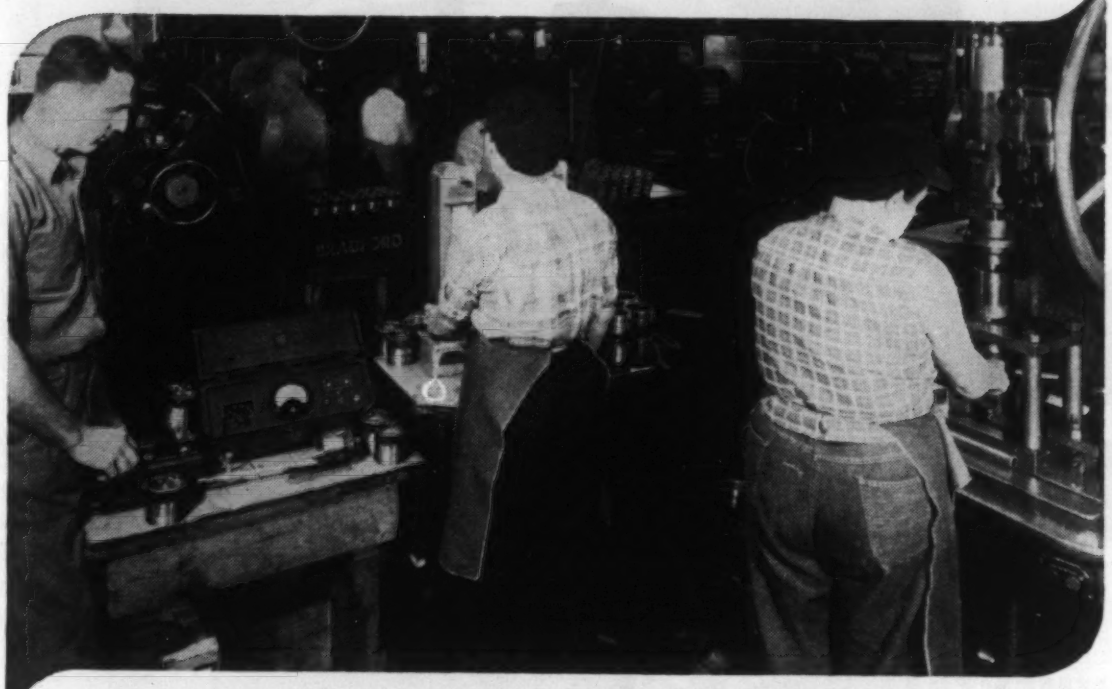
"An Essential Unit of Our Production Line"



says BRADFORD PRODUCTION MACHINE COMPANY about the PROFILOMETER

"In our production of cylinders for hydraulic steering units, we consider the Profilometer an essential piece of equipment . . . and the spot for it is right on our production line," says Bradford Production Machine Company of Detroit.

The above illustration shows the three final operations of the production line. The I.D. of the cylinder is bearingized, gaged for dimensional tolerances, and then surface roughness is checked with the Profilometer. Only seconds away from the machining operations, the Profilometer provides the information necessary to assure constant control of the specified surface finish—which, in this case, is from four to six microinches.

In plants throughout the world—wherever control of surface roughness is a requirement—you will find the Profilometer in use as a fast, simple and accurate shop tool. On the job at the time when surfaces are being produced, it can and does make possible many worthwhile savings in production costs.

To learn how the Profilometer can be used to advantage in your plant, write for these free bulletins.

Profilometer is a registered trade name.

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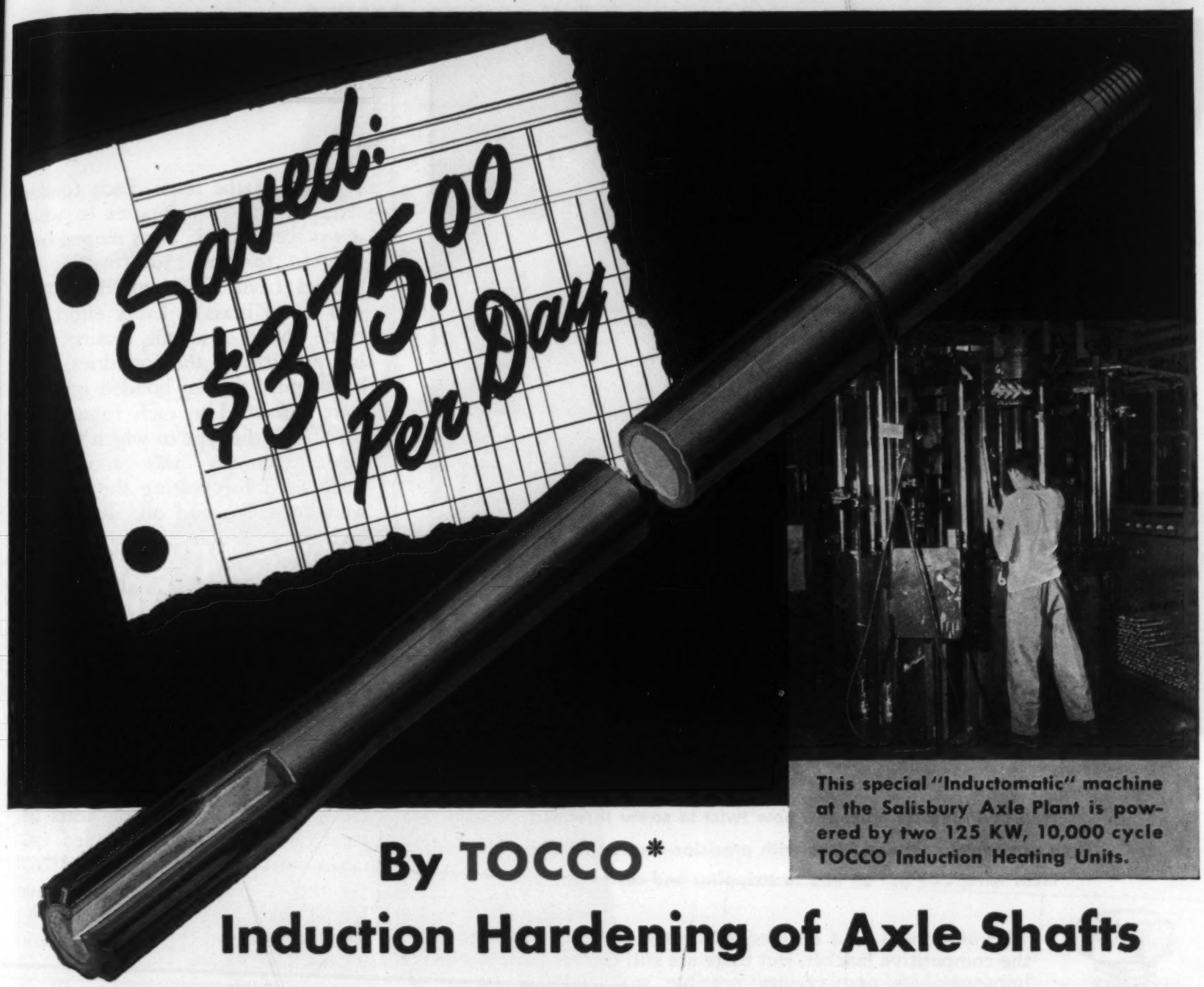
News Digest

Heindl of the NBS refractories laboratory in cooperation with certain crucible manufacturers and nonferrous foundries.

Graphite crucibles are used by several hundred nonferrous metal foundries throughout the United States to melt metal for casting parts indispensable for both civilian and military purposes. These crucibles are made from graphite flakes, bonded either with clay or with organic binders such as tar or pitch; the latter type is known as carbon-bonded. Graphite is similarly used in the manufacture of ladle stopper heads required by the steel industry. Until now, large-flake graphite imported from Madagascar has been used for these purposes almost to the exclusion of other graphites. Because of the strategic importance of crucible graphites, now being stockpiled, the Army-Navy Munitions Board suggested that the National Bureau of Standards undertake the present study. As a result of the NBS findings, a Pennsylvania graphite mine is being reactivated so as to insure the availability of domestic graphite if the supply of lower-cost Madagascar graphite should be cut off.

The American Crucible Co. and the National Crucible Co. cooperated with the Bureau in manufacturing the crucibles used for the study. Graphites from the three sources—Madagascar, Alabama and Pennsylvania—were furnished by the Bureau to the manufacturers in various combinations of flake sizes. To prevent identification of its source by anyone other than the NBS investigators, each batch of graphite was designated only by a key letter. Except for the use of NBS-supplied graphite, the manufacturers followed their regular production procedure in manufacturing the test crucibles. Each crucible was permanently identified by number and also by a secret mark. After inspection for defects, one finished crucible of each type was taken to NBS for laboratory determination of moduli of rupture and elasticity, and the others were shipped to brass-melting foundries for tests of service life.

Six foundries cooperated in service-testing the crucibles. The selection of foundries was limited to those melting brass and having enough furnaces in operation to insure rapid



This special "Inductomatic" machine at the Salisbury Axle Plant is powered by two 125 KW, 10,000 cycle TOCCO Induction Heating Units.

By TOCCO* Induction Hardening of Axle Shafts

WHAT progressive engineers at the Salisbury Axle Division of Dana Corporation have done with Induction Heating for hardening automotive axle shafts suggests comparable savings for your products. Note this report:

SAVINGS of $375.00 per day caused by increased output and switch from SAE 4140 to SAE 1033 steel made possible by induction hardening.

LESS MACHINING time because shaft of SAE 1033 steel is completely machined prior to hardening. Tool cost cut in half—turning time reduced from 2 minutes to 30 seconds.

PRODUCTION DOUBLED. Formerly 50 axle shafts per hour with conventional combustion type heating—now 120 per hour with TOCCO.

PRODUCT IMPROVED. Torsional fatigue has increased 200%. The shaft is no longer a compromise between durability and machinability. It is hardened to 55 RC and drawn back to 43-47 RC. Degree of hardness and depth is accurately controlled.

TOCCO Engineers will gladly survey *your* operations for similar cost-cutting results in hardening, heat-treating or brazing—without obligation.

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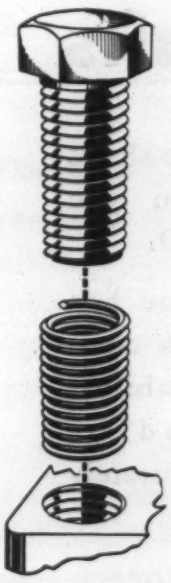
Heli-Coil* **Inserts present a new twist to screw threads. They armor your tapped holes with precision-formed stainless steel wire, and put an end to stripping and corrosion.**



This alone will be a decided advantage for your products in the competitive market. But there are still further basic design improvements and savings possible with *Heli-Coil* Inserts.

Smaller... fewer... or shorter cap screws can now provide the necessary holding power with *Heli-Coil* Inserts... even with short thread engagements. Cap screws can be repeatedly removed and replaced without damage to the threaded member when tapped threads are protected by *Heli-Coil* Inserts.

Make your designs cleaner, with lighter bosses and smaller flanges – by the use of *Heli-Coil* Inserts. Eliminate heavy studs and bolt-and-nut assemblies by using cap screws and *Heli-Coil* Inserts. In addition, your product is permanently protected against thread corrosion and seizure.

The value of *Heli-Coil* thread engineering to you is quickly verified. Take a minute now to get the latest information. It costs you nothing...mail coupon today!

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News Digest

progress of the tests. Each foundry received crucibles of sizes to which it was accustomed. Sizes ranged from No. 50 to No. 150 (melting capacities from approximately 180 to 470 lb. of brass). Every effort was made not to upset the routine melting practices of the foundries. Carbon-bonded or clay-bonded crucibles were furnished to each foundry according to the type to which the particular foundry was accustomed. Fuels used for heating the furnaces were coke, gas and oil. Records of each heat and other pertinent information were kept on log sheets supplied by the National Bureau of Standards.

Service life of the crucibles made from the Alabama and Pennsylvania graphites averaged fully as good as that of crucibles made from Madagascar graphite. Carbon-bonded crucibles in general gave about twice as many heats as did clay-bonded crucibles. The number of heats before failure of carbon-bonded crucibles averaged 81.3, 107.7 and 76.0 for the Alabama, Pennsylvania and Madagascar graphites, respectively; for the clay-bonded crucibles the corresponding figures were 40.6, 36.7 and 37.6. Graphite flakes smaller in size than those preferred by some manufacturers of carbon-bonded crucibles apparently did not impair service life.

Predicts Tremendous Use of Rubber in Passenger Conveyor Belts

America's rubber industry stands on the threshold of a new contribution of transportation progress that may surpass the pneumatic tire in importance, Colonel Sidney H. Bingham, chairman of the Board of Transportation of New York City, said recently. Colonel Bingham predicted that with widespread acceptance of moving platforms for city transit, new rubber for such conveyor belts could approach the volume now consumed by the automotive industry.

Automotive requirements, with tires a major factor, currently account for approximately 70% of the 1,215,-

Squeezed like an accordion, welded tubing demonstrates uniform strength

● This compression folding of a section of electric-welded steel tubing produces no cracks or flaws. Such uniform strength is proved in many other severe cold forming operations. U. S. Bureau of Standards tests show that the weld is as strong as the wall, and that it has the same qualities as the steel.

Investigate the economy and physical advantages of Brainard welded steel tubing in *your* products. Write Brainard Steel Division, Dept. X-12, Griswold Street, Warren, Ohio. An integrated producer; offices throughout the U. S.

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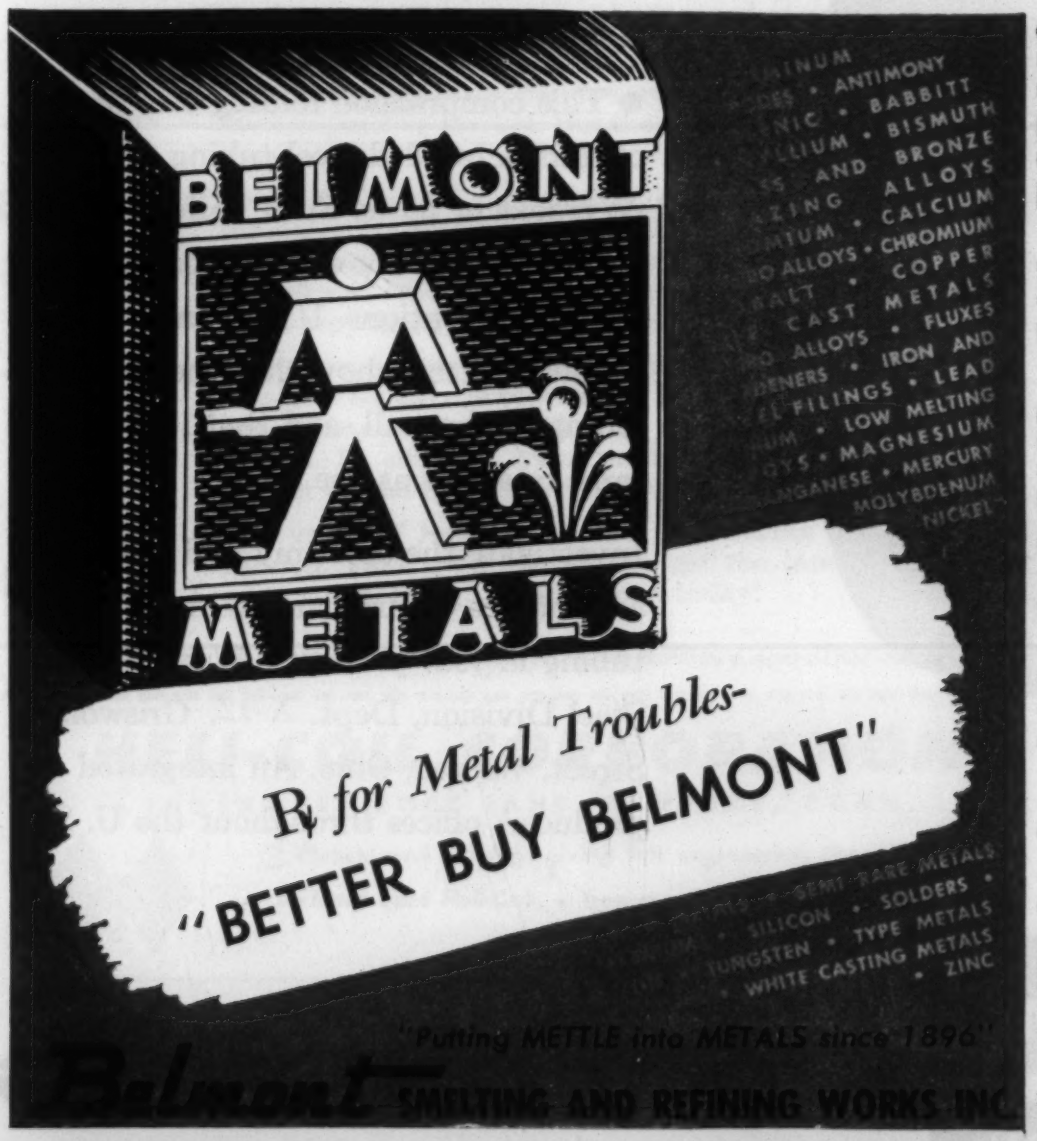

ALL METALS · ALL ALLOYS · ALL FORMS

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News Digest

000 tons of rubber consumed in the United States annually.

"While the automobile and truck have been responsible for the tremendous expansion of the rubber industry to date," Colonel Bingham said, "a new era in transportation progress comes into view with the perfection of the passenger conveyor. Somewhere around 80 long tons of rubber per mile will be required to fabricate belting for a two-way transportation system.

"Aside from subway transit use, upon which considerable attention is being focused at the moment, there are many other potential outlets for the moving platform. I have been consulted on the feasibility of moving sidewalks for an airport terminal, a supermarket, and a baseball stadium. I have recommended their consideration in all three cases."

News of Engineers

Appointment of *A. N. Abelson* as vice president in charge of manufacturing of the Aro Equipment Corp. has been announced. Formerly general manager of the Cleveland plant, Mr. Abelson will now be responsible for all production. Also announced by the company was the appointment of *John R. Markey* as assistant to the vice president. Prior to his reeent promotion, Mr. Markey had been aircraft sales manager.

At the annual stockholders meeting of Alloys & Products, Inc., *Andrew E. St. John* was elected president of the company to succeed *Henry Hecht,* deceased. At the same time, *C. A. Hecht* was elected vice president and *Wilson Hecht* was made a member of the board of directors.

Dr. *Raymond H. Hartigan* has been appointed assistant director of research on the executive staff of the Mellon Institute.

The Royal New Zealand Aero Club's Musick Memorial Trophy for 1951 was recently awarded to two American engineers, *John E. Lindberg, Jr.* and *James W. Wheeler,* for their joint development of the Sperry Engine Analyzer, an electronic device that detects, locates and identifies detailed ignition and mechanical troubles in aircraft power plants during actual operation. The Messrs. Lindberg and Wheeler accomplished their devel-

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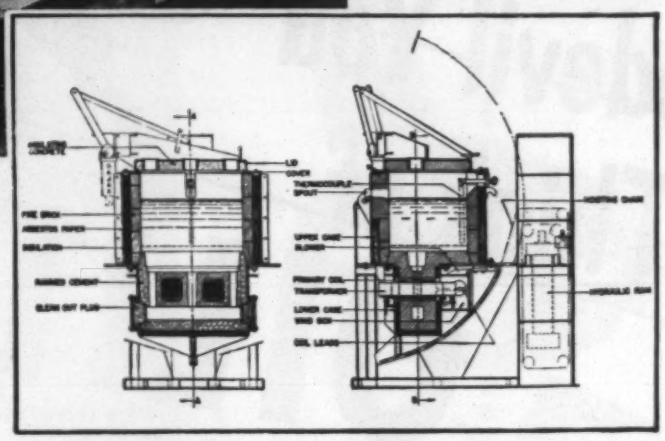
AJAX TAMA-WYATT INDUCTION FURNACES

Cut Foundry Melting Cost

Accurate records at the National Pressure Cooker Co., Eau Claire, Wisc., show that over a two-year period the AJAX Induction Furnace was capable of reducing melting costs by as much as 40%.

Cross-section drawings of 166 kW. twin-coil AJAX Induction Furnace with hydraulic tilting device.



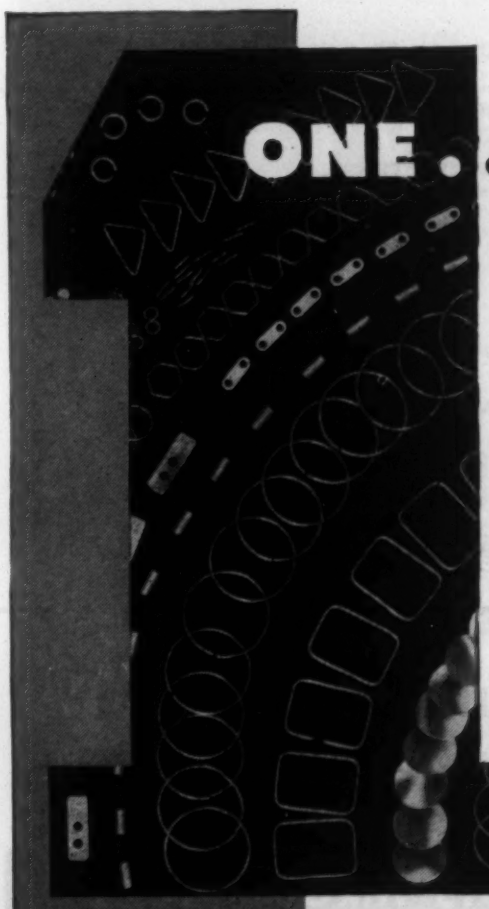
Partial view of National Pressure Cooker Co.'s melting room showing AJAX Induction Furnaces.

Due to the nature of their use, pressure cooker castings must maintain exceptionally high standards of casting quality. Not only does the induction furnace effect a saving in melting cost but, in addition, working conditions are greatly improved.

AJAX ENGINEERING CORP., TRENTON 7, N. J.

AJAX TAMA-WYATT INDUCTION MELTING FURNACE

AJAX ELECTRO METALLURGICAL CORP., and Associated Companies
AJAX ELECTROTHERMIC CORP., Ajax Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax Wyatt Induction Furnaces for Melting



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News Digest

opment work while Mr. Lindberg was in the employ of Pan American World Airways, Inc., as staff engineer for the Pacific-Alaska Div. and while Mr. Wheeler was serving—as he currently is—as head of the Engine Instrument Dept., Sperry Gyroscope Co. Mr. Lindberg is now president of Lindberg Engineering Co.

Harvey H. Morrison has joined Stillman Rubber Co. as vice president in charge of production.

Appointment of *E. E. Schaffer* and *E. E. Williams* as staff engineers has been announced by The Harold F. Howard Co.

Carborundum Co. has anounced the appointment of *Joseph S. Imirie* to the newly created position of assistant to the president. Mr. Imirie has been with the company since Jan. 1952, serving in the investigation of new products to be added to the company's present line.

W. L. Newhall has been appointed director of the Dept. of Research and Development for the Dravo Corp. and subsidiaries. Named as assistant directors were *C. R. Horton, Jr.* and *A. J. Liebman*.

Appointment of *Frederick E. Wenzel* as general manager of Trent Tube Co. has been announced. Mr. Wenzel had been works manager of the company since 1949.

Tom B. Nantz has been named manager of B. F. Goodrich Chemical Co.'s new five million dollar vinyl plastic monomer plant now in its final construction stages at Calvert City, Ky. *Anton Vittone, Jr.* will take over Mr. Nantz' former duties as plant manager at the Institute, W. Va., GR-S rubber plant, operated for the Government by the company.

Frank O. Hoagland, master mechanic of Pratt & Whitney Div., Niles-Bement-Pond Co., received the Standards Medal for Leadership in the development and application of voluntary standards given annually by the American Standards Assn.

Appointments to fill two newly created production staff posts at the Chrysler Detroit Tank plant have been announced: *Hayward F. York,* plant engineer since June 1952, was named factory manager, and *Roman Andrysiak,* recently appointed superintendent of assembly, was promoted to assistant general superintendent under Mr. York.

William M. Clossey has been elected secretary and treasurer by the board of directors of Cowles Chemical Co.

Hooker Electrochemical Co. has recently employed the following technical people: *Donald J. Stone* as a mechanical engineer; *Edward A. Hutton* as a chemical engineer; *Alice M. Fulton* as a librarian in development and research; *Robert*

VACUUM FACTS

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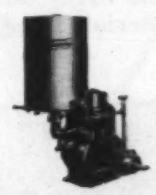

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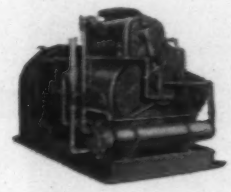

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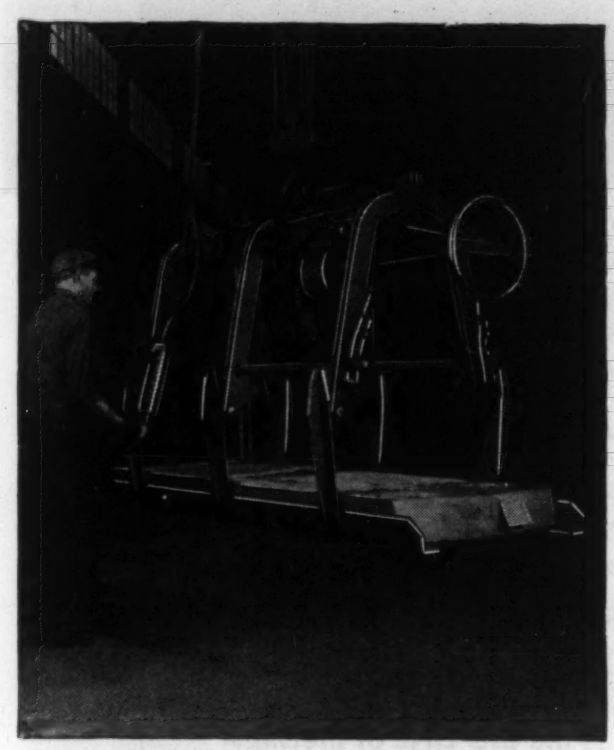

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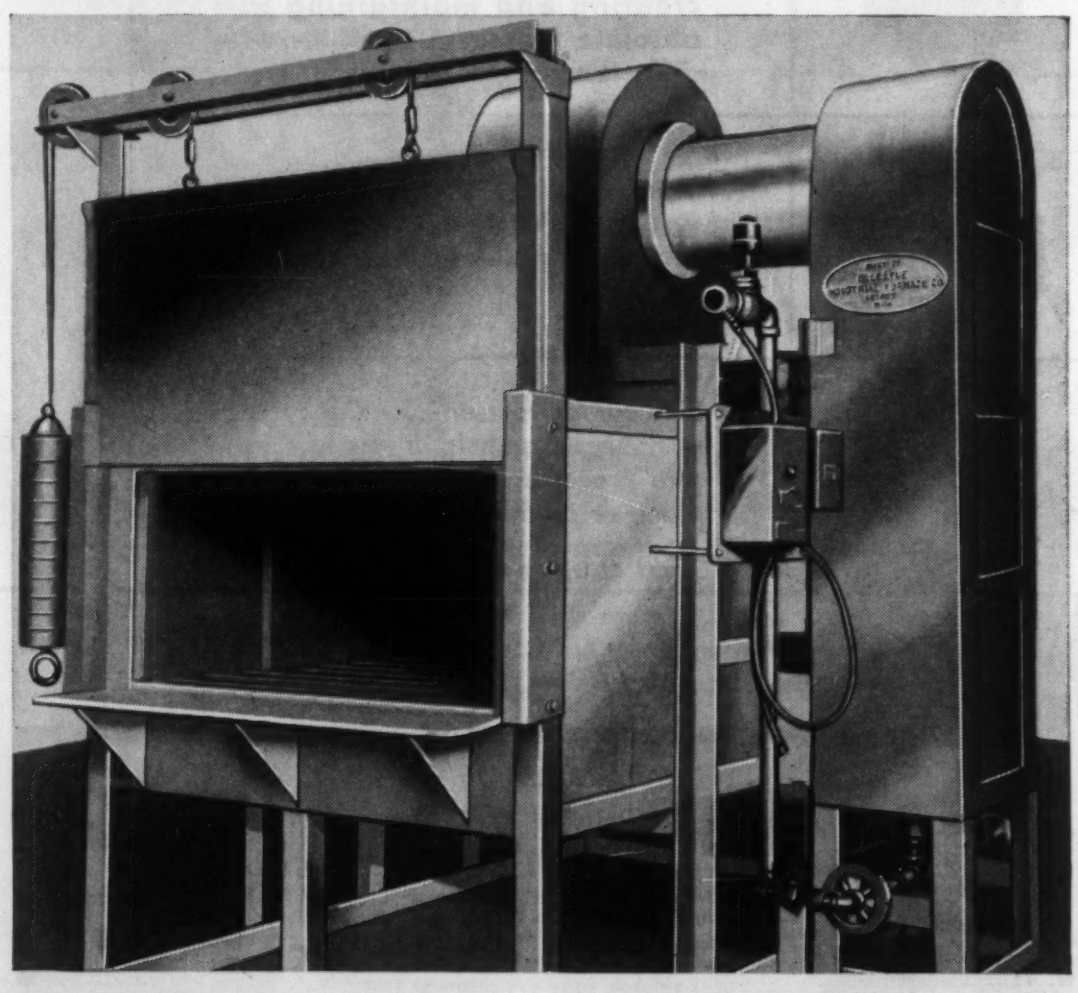
HANDLE SHEETS with C-F LIFTERS



Batch type furnace for the heat treating of aluminum alloys—consists of atmosphere type burner mounted on the lower end of the combination chamber to reheat the recirculated hot air through the furnace. A High Heat insulated recirculating fan is standard equipment for recirculating the heated air. This method of heating holds temperature with little or no variation. Mounting the burner in the duct, eliminates the necessity of an extra heating unit. . . . Send us your heat treating problems . . . our engineers will make a proposal without obligation.

BELLEVUE INDUSTRIAL FURNACE COMPANY
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News Digest

H. Pugh, as a chemist in the works laboratory.

J. D. Greensward was named vice president, director of manufacturing, General Machinery Div., Allis-Chalmers Manufacturing Co. at the regular meeting of the firm's board of directors. *P. F. Bauer* has been named general manager of the Norwood Works and manager of the firm's Apparatus Department, succeeding Mr. Greensward. Further expansion of the company's research activities has been revealed with the announcement of the addition of six more scientists. The newly named men are: *Matt Bushner, Walter Edens, W. B. Harrison, Dimitri Kececioglu, Donald F. Kuemmel* and Dr. *Arthur B. Michael.*

Horizons Inc. has announced the following appointments: Dr. *Yin-Yuan Li,* as research supervisor in the Physics Dept. of the Cleveland laboratory; Dr. *Meyer L. Freedman,* as head of the Chemistry Dept.; Dr. *John M. Finn, Jr.,* as project supervisor in the Chemistry Dept.; Dr. *Tien-Shih Liu,* as senior research associate in the Metallurgy Dept.; *Virgil E. Straughan,* as a research supervisor in the Metallurgy Dept. *Harry F. Ross,* as a research supervisor in the Metallurgy Dept.

The formation of an aircraft division of the American Car and Foundry Co. has been announced. At the head of the new division as vice president is *Clifford W. Sponsel,* who, prior to his election, was vice president in charge of operations for Brooks and Perkins, Inc.

The Oliver Corp. has announced the following personnel changes: *C. O. Bryson* has replaced *F. L. Wilson* as method superintendent; *Dean Spear* has replaced *Ray Engelhart* as chief tool designer.

The Mycalex Corp. of America has announced the appointment of *R. A. Humphrey* as engineer, research and development.

Dr. *V. E. Wellman* has been appointed assistant manager of the Intermediate Rubber Chemicals Dept., Calco Chemical Div., American Cyanamid Co. Since 1951 Dr. Wellman has been director of process engineering for Calco.

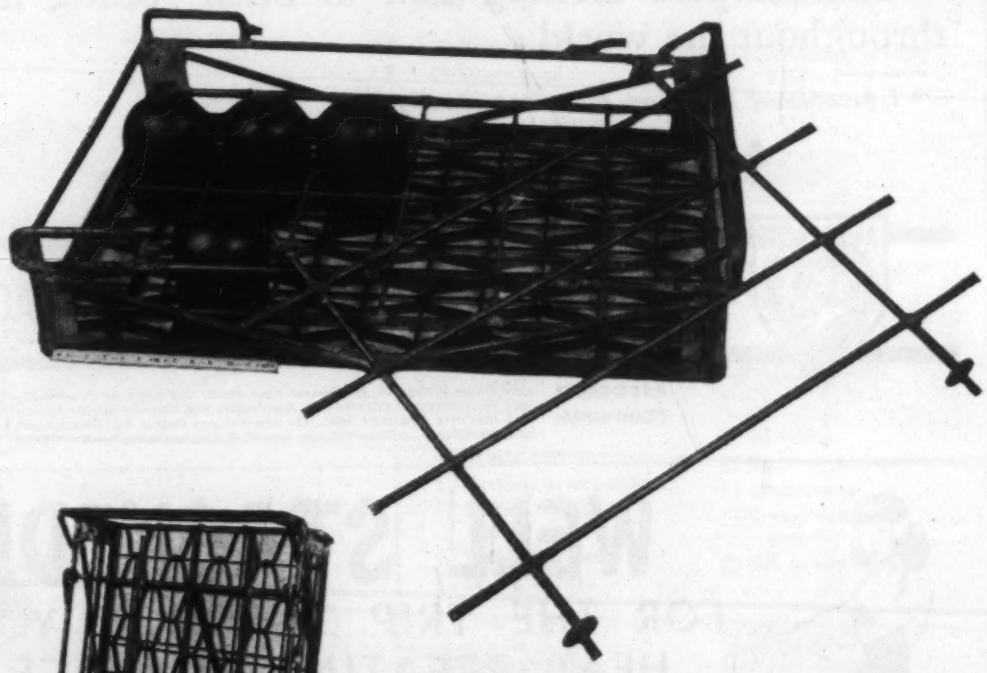
Sidney Shore, assistant professor, and *E. W. Rothfull, Jr.,* graduate student, both of the Civil Engineering Dept., Princeton University, shared a first prize award of $500 under Category "A", Welding Engineering & Theory, of the $2000 International Prize Competition for papers "Technological and Research Aspects, Advances and Advantages of the Use of Lower Melting (Lower than Parent) Filler Metals in the Non-Fusion Welding Process", conducted by Eutectic Welding Alloys Corp. Winner of the second prize under this category was *H. Edward Flanders,* University of Utah,

ROLOCK

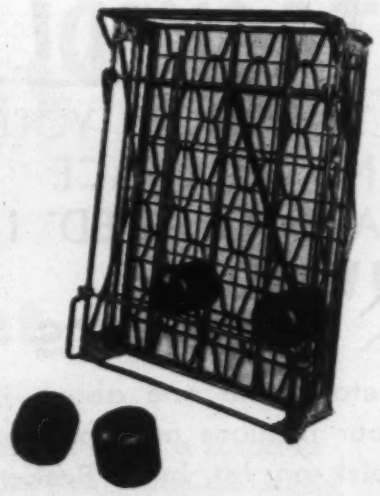
FABRICATED HEAT AND CORROSION RESISTANT ALLOYS

New Equipment For Processing STEEL SHELL CASES

Before each draw in forming steel shell cases, the material goes thru a cycle of processes while contained in work holders. Details of processes and handling, however, will vary in different plants.



Rolock has built this Inconel fabricated-welded basket to handle the cup and first draw. (A deeper one handles the later draws.) Traveling on rolls and chains, now flat, again on end, suspended and tilted, always heavily loaded, the basket is designed to stand up under an unusual variety of conditions. The cases, separated by dividers, rest on the bottom. Handling two depths of cases, the retaining cover fastens at two heights above bottom. Basket weight 110 lbs., load 290 lbs., ratio exceeds 2½ to 1. By using a high nickel alloy, true conservation of nickel is achieved in cycles of heat, quench, and acid.



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(Corrosion Resistant Section)

just off the press. It contains and describes 102 photos of the latest equipment for today's requirements.

This is but one example of Rolock special shell case equipment. Other types, as well as fixtures used before the cupping operation . . . and others used after the final draw, for washing and lacquering...have been designed. Ask us for details.

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AJAX ELECTRIC COMPANY, INC., The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ENGINEERING CORPORATION, Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces

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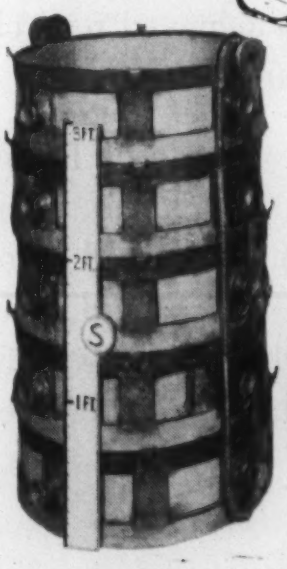
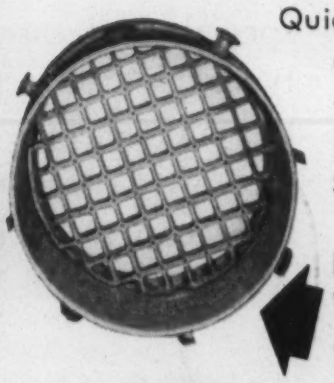


Each basket retains the one above it. Two or four trunions are optional. Quick-on lift bars. Baskets are durable, lightweight — heat resistant alloys. Bottom grid is reversible. Send for literature.



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Reversible Bottom Grid. Wire Screen Bottom Liner available.

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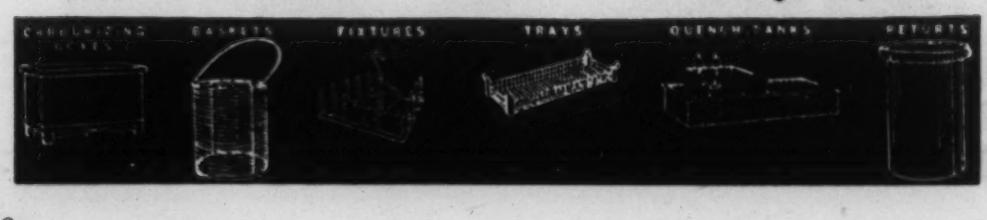

News Digest

and the third prize was shared by *Paul Broadstone and Fred Salmons* of the R. G. LeTourneau Corp., Longview, Tex.

Panascan, Inc. has announced the appointment of *Ralph A. Anderson* to vice president and chief engineer of the company.

Elvin P. Carney, chief control chemist of Metals Disintegrating Co., was a guest at a recent dinner held in his honor, celebrating his 25 years of service with the company.

Dr. *Jason Saunderson* of Dow Chemical Research Dept. has been appointed director of engineering at Baird Associates, Inc. *David Z. Robinson* and *W. G. Langton* have been appointed as assistant directors of research.

Appointment of *John V. Schweppe* as production superintendent at the Shelbyville, Ind., Fiber Glass producing plant has been announced by Pittsburgh Plate Glass Co.

T. J. Kinsella, who has been in charge of the Barrett Div., Allied Chemical & Dye Corp. as executive vice president, has been appointed president of this division.

William R. Barrett has been appointed vice president and general manager of Rinshed-Mason's Detroit plant.

Blaw-Knox Co. has appointed *George L. Dirks* to the position of general manager of its Blaw-Knox Div. at Blawnox, Pa. Mr. Dirks succeeds *D. V. Sherlock*, who returned from retirement to serve temporarily as acting general manager.

At a recent meeting of the board of Hilo Varnish Corp., the resignation of *Carl J. Schumann* as president and director was accepted. At the same meeting, *Eugene E. Morton* was elected president to succeed Mr. Schumann.

The election of *Kenneth D. True* as vice president and general manager of United Stove Co., a recently acquired Gar Wood subsidiary, has been announced.

Hooker Electrochemical Co. has announced that *Alexander D. Kirchitz* has been placed in charge of research technical literature and that *Jerome Wilkenfeld* has been appointed supervisor of process study.

William L. Batt, minister in charge of the Economic Cooperation Administration mission to the United Kingdom and president of SKF Industries, Inc., has been awarded the Howard Coonley Medal for long and distinguished service in the standardization movement. Presentation will be made on Nov. 25 at the 34th annual meeting of the Association at the Waldorf-Astoria.

Five engineers have received promotions at Worthington Corp., according to a recent company announcement: *John E. Lancaster* has been appointed assistant

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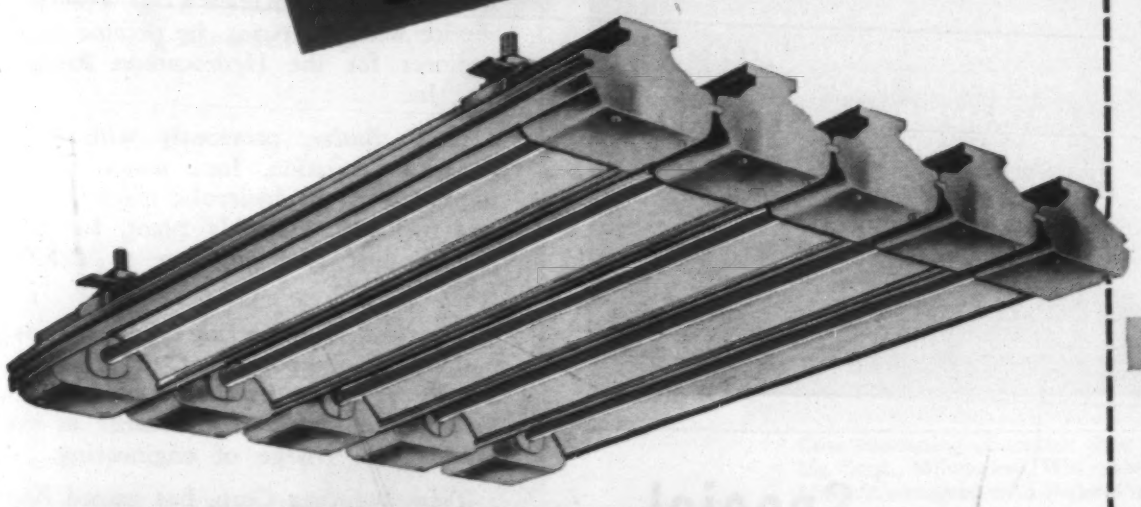

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- ☐ Preheating cloth
- ☐ Curing vinyl
- ☐ Post-forming
- ☐ Curing tubing

METALS

- ☐ Heating molds
- ☐ Degreasing
- ☐ Paint baking
- ☐ Drying piston rings
- ☐ Baking wrinkle paint
- ☐ Welding preheating
- ☐ Drying automotive parts
- ☐ Preheating steel rolls
- ☐ Dehydrating refrigeration coils

GLASS

- ☐ Drying bottles
- ☐ Heating safety glass
- ☐ Setting dye on glass cloth
- ☐ Preheating lenses
- ☐ Drying mirrors

ELECTRICAL

- ☐ Baking armatures
- ☐ Drying marine equipment
- ☐ Sealing headlights and television tubes
- ☐ Drying varnished wire
- ☐ Drying carbon resistors
- ☐ Drying color coding

FOUNDRIES

- ☐ Drying sand cores
- ☐ Skin drying of molds
- ☐ Comfort heating

FOOD

- ☐ Warming
- ☐ Drying baking pans
- ☐ Dehydrating crackers
- ☐ Baking biscuits
- ☐ Dehydrating coconuts

TEXTILES

- ☐ Dehydrating braided material
- ☐ Drying Nylon thread
- ☐ Dehydrating woolen cloth
- ☐ Setting flock

RUBBER

- ☐ Curing
- ☐ Heating rubber glue
- ☐ Curing latex

PRINTING

- ☐ Ink drying
- ☐ Static elimination
- ☐ Glue drying
- ☐ Drying varnished paper
- ☐ Silk screen drying

CERAMICS

- ☐ Drying frit
- ☐ Drying glaze
- ☐ Drying pottery

MISCELLANEOUS

- ☐ Sealing storage batteries
- ☐ Setting adhesives and cements
- ☐ Curing tobacco
- ☐ Melting wax
- ☐ Drying photographic negatives and prints
- ☐ Dehydrating kraft paper

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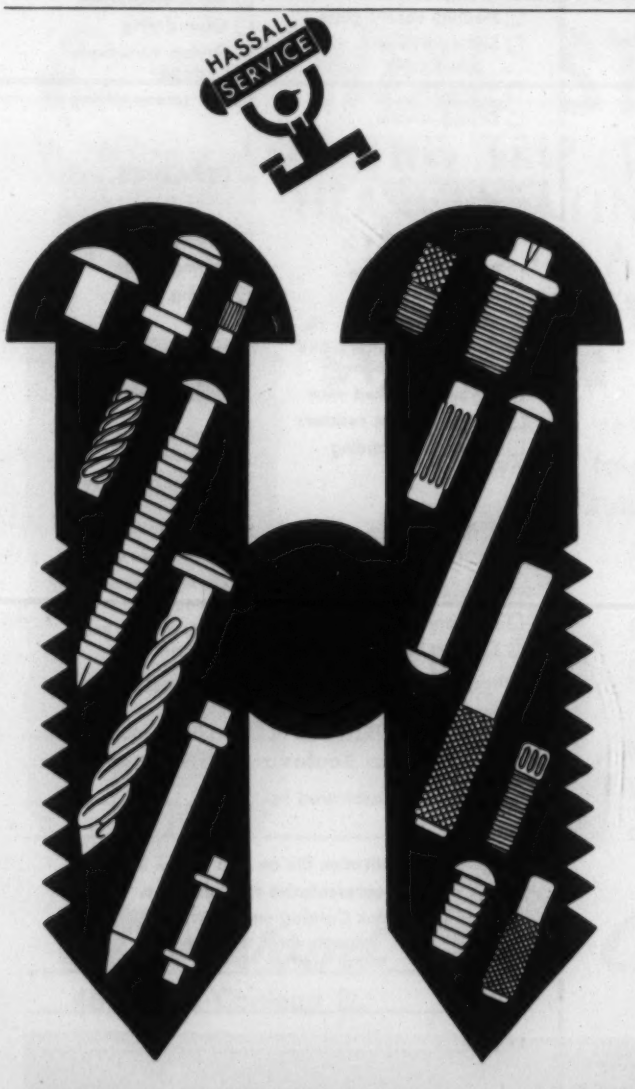

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News Digest

chief engineer of the Air Conditioning and Refrigeration Engineering Div.; *William C. Osborne* has been named manager of the Research and Development Dept.; *Norman L. Meyerson* has been appointed assistant manager of the Research and Development Dept.; *Frederick C. Gilman* has been appointed research engineer; and *T. A. Herman* has been named assistant chief engineer of the Reciprocating Engineering Div.

Howard T. Brinton has been elected president of the Phelps Dodge Copper Corp., fabricating subsidiary of the Phelps Dodge Corp.

The appointment of *J. J. Barker* as head of the Process Dept. of Walter Kidde Nuclear Laboratories has been announced. Mr. Barker was formerly chemical engineer for Kellex Corp. Following service with the Army, he became design engineer for the Hydrocarbon Research Co., Inc.

J. T. Butler, previously with North American Aviation, Inc., where he was in charge of the hydraulic machine shop and hydraulic assembly plant, has been named chief tool engineer at TEMCO Aircraft Corp.

American Engineering Co. has announced the appointment of *H. Pagels* as vice president in charge of manufacturing, and of *F. C. Messaros* as vice president in charge of engineering.

Tube Reducing Corp. has named *Peter R. Prunkl* as new plant manager.

According to a recent announcement from White Motor Co., *H. R. Stickel* has been named assistant to the president.

Appointment of *Irving R. Taylor* to the position of assistant manager of the Warren Machine & Die Div., American Welding & Mfg. Co., has been announced.

Sam R. Read has been named staff engineer of Visi-trol Engineering Co.

Thornton G. Graham, vice president of the B. F. Goodrich Co. since 1928, will retire on Jan. 31, 1953. At the time of Mr. Graham's retirement, *Arthur Kelley*, with the company since 1925, will become vice president-manufacturing.

Dr. *Martin A. Edwards* has been named manager of engineering of the X-Ray Dept., General Electric Co. Dr. Edwards, who has been engineering manager of the company's General Engineering Laboratory, succeeds *William J. Fleming*, whose appointment as general manager of the G-E Lighting and Rectifier Dept. was recently announced. The retirement of Dr. *A. F. Dickerson* as general manager of the Lighting and Rectifier Dept. after 42 years with the company has also been announced. Dr. Dickerson will remain with G-E as a consultant to the department.

S. Frederick Magis, consulting engineer

Here's the new-design tube that gives

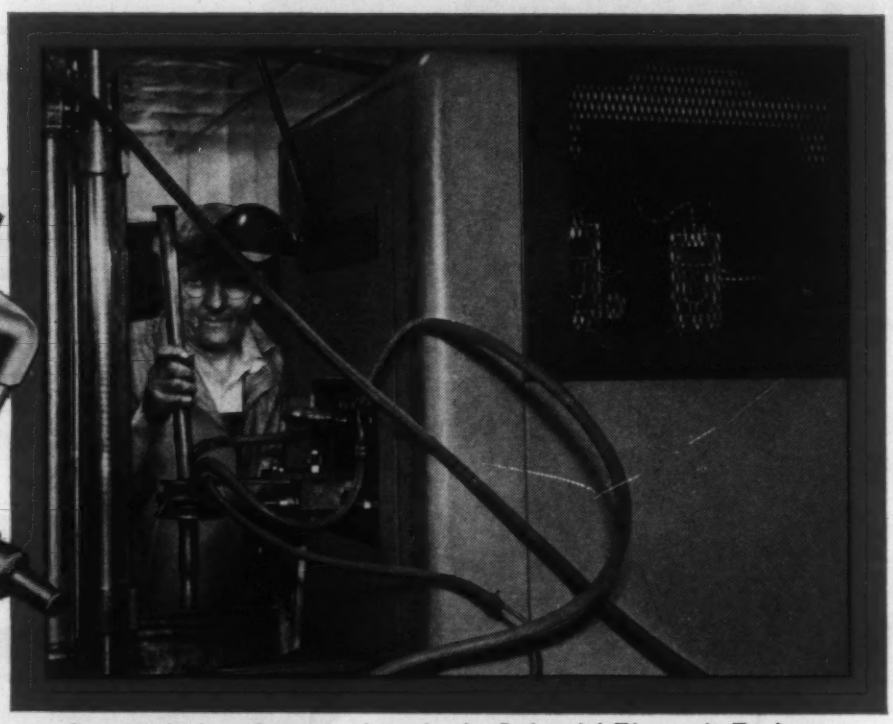
INDUCTION and DIELECTRIC HEATING

"PLUS-ENDURANCE"

For Today's Rugged Production Pace in Metals, Plastics, Wood, Rubber . . .

Federal's F-892

(F-892-R Air-cooled)



Case hardening of tractor shoe pins by Industrial Electronic Engineering Corp., Milwaukee, Wis., using 20 KW Allis-Chalmers induction heating unit equipped with Federal's rugged and reliable F-892 power triode.

First with the new proved-design

DOUBLE HELICAL FILAMENT

- **Does away with bowing**
- **Eliminates filament-to-grid shorts**
- **Greatly increases tube life**

OUTSTANDINGLY DEPENDABLE IN MOMENTARY OVERLOADS

SEALING, soldering, brazing, bonding, molding, annealing, drying, pre-heating . . . *whatever* your electronic heating application . . . Federal's re-designed F-892 power triode really keeps production lines rolling . . . *by reducing time-wasting shut-downs for tube replacements!*

Incorporating Federal's new *Double Helical Filament* (which eliminates filament-to-grid shorts) the F-892 has been especially designed to withstand the hard punishment of sudden and extreme load changes . . . to resist mechanical shock and steady vibration . . . to stay on the job *longer* . . . under the toughest conditions.

Back up *your* induction or dielectric heaters with the ruggedness and *plus*-endurance of Federal's F-892. Its proved-design assures you the highest operating efficiency for 10 and 20 KW equipments . . . with *lower* tube costs through *longer* life and *fewer* replacements!

Write today for full information on Federal's F-892 or F-892-R.

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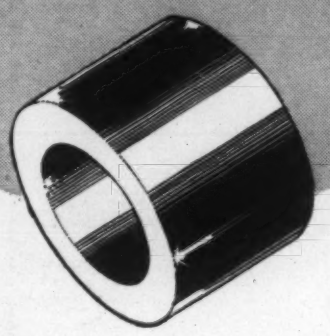

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Widely Used Where Ordinary Oil Lubrication Is Impractical or Impossible.

EXCELLENT DURABILITY • CONSTANT CO-EFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE — EVEN WHERE OIL SOLIDIFIES OR CARBONIZES • OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE AND OTHER LIQUIDS • EXCELLENT FOR CURRENT-CARRYING BEARINGS

GRAPHALLOY materials are also in wide use for oil-free, self-lubricating piston rings, seal rings, thrust washers, friction discs, pump vanes etc.

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News Digest

with 26 years experience in the steel industry, has been named steel technologist at Armour Research Foundation of Illinois Institute of Technology.

Henry W. Willard has been appointed factory manager of United States Rubber Co.'s Passaic, N. J., plant. Mr. Willard succeeds *William C. Bowker,* who is retiring.

Fred H. Haggerson, chairman of the board of Union Carbide and Carbon Corp., died recently after a short illness.

The death of *William C. Ireland,* assistant to the president, formerly vice president and general manager of Bundy Tubing Co., has been announced.

Hanson-Van Winkle-Munning Co. has announced the death of *George G. Knecht,* district manager. Mr. Knecht spent his entire business career in the electro-plating field and was well known throughout the industry.

News of Companies

To fulfill an increasing number of subcontracts for aircraft accessories, *Ronson Art Metal Works, Inc.* has equipped a new and additional plant at N. 13th St. and Park Ave., Newark.

Top government defense agency officials recently joined with *Aluminum Co. of America* executives and Washington State dignitaries to dedicate the nation's newest aluminum producing unit built by Alcoa at Wenatchee, Wash.

Haynes Stellite Co. was recently notified that the government has given approval to the U. S. Air Force to purchase the *Aladdin Industries* plant in Alexandria. The proposed Alexandria plant has been under consideration by Stellite since June. It will be owned by the Air Force but operated as a branch of the Kokomo Haynes Stellite Div. of the *Union Carbide and Carbon Corp.* The plant will manufacture precision castings for use in jet engines.

The *American Chemical Paint Co.* has announced that it has acquired office and plant facilities on the West Coast and expects to be operating there by the first of November. The new ACP plant is located at Niles, Calif. Heading up the new branch will be George H. Williamson.

Yardley Plastics of Canada Ltd. is investing $110,000 in new plant expansion. Plans call for construction of a new con-

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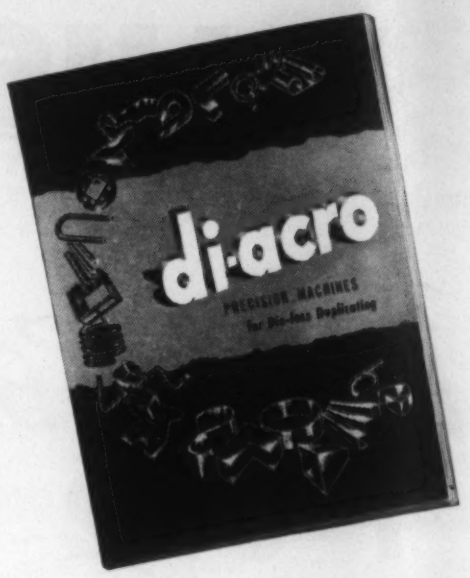

New catalog shows how

"DIE-LESS DUPLICATING" SAVES TOOLING COSTS, SPEEDS PRODUCTION

New 32-page catalog, chock-full of operating photographs, shows the wide variety of parts that can be formed and fabricated—often without the use of dies—by Di-Acro Metalworking Machines. Gives complete machine specifications and material capacities on 36 hand and power operated models in handy reference tables. Explains Di-Acro Engineering Service—it has helped solve many problems. Write for your copy now.

Di-Acro is pronounced Die-ack-ro. It is the registered brand name for both hand and power operated Di-Acro Benders, Brakes, Notchers, Punch Presses, Rod Parters, Rollers, and Shears.

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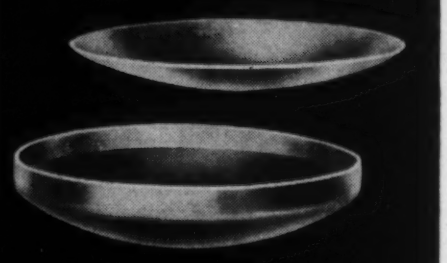
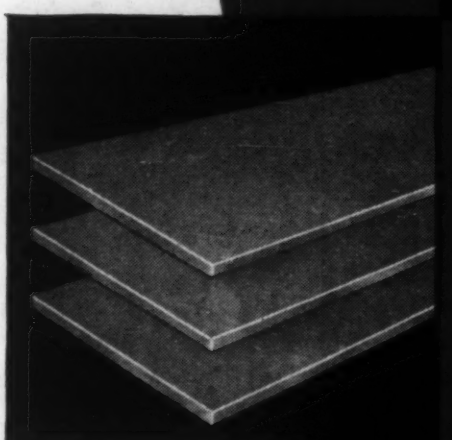
Each of these products is a specialty with us, which means that every order, large or small, receives our careful, individualized supervision—painstaking attention in every processing detail from start to finish.

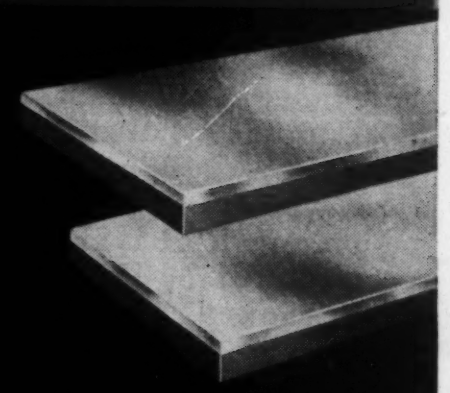
We would welcome an opportunity to show you how our specialized facilities can supply you with steel and steel products that are tailored to meet your most exacting specifications. For additional information write to Claymont Steel Products Department, Wickwire Spencer Steel Division, Claymont, Del.



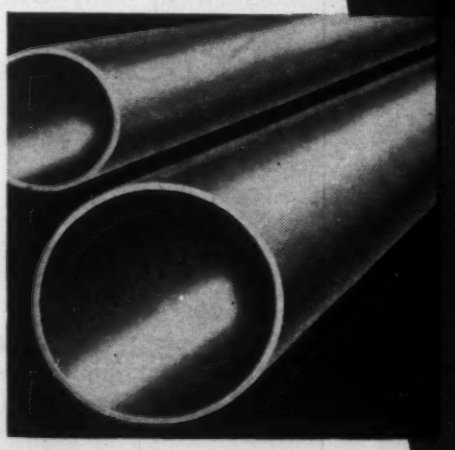
FLANGED AND DISHED HEADS



ALLOY AND CARBON STEEL PLATES



STAINLESS-CLAD STEEL PLATES



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THE COLORADO FUEL AND IRON CORPORATION
CF&I

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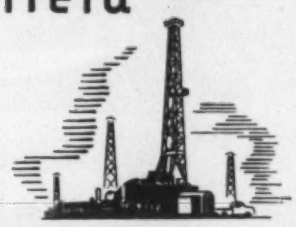
In the field —



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News Digest

crete-block building with 7500 sq ft of floor space.

Control Engineering Corp. has begun operations in its new enlarged headquarters at 560 Providence Highway in Norwood, Mass.

Mallory-Sharon Titanium Corp. has announced the opening of a West Coast office. George H. Denny will be in charge and will be temporarily located at 1338 S. Lorena St., Los Angeles.

A merger has been effected between the *Coleman-Petterson Corp.* and *Fanner Metal Products Co.*, both of Cleveland. *Fanner Metal Products Co. — Coleman Div.*, has been formed as a result of this consolidation.

Completion of a new building at 125 Manchester Pl., Newark, to house one of its affiliated organizations, *Bart Manufacturing Corp.*, has been announced by the *Bart-Messing Corp.*

Pittsburgh Plate Glass Co. is the donor of a new multiple fellowship organized this autumn at *Mellon Institute* in Pittsburgh. The administrative fellow for the group is Dr. T. H. Davies.

A new 8000 sq ft foundry and office building has been erected by *Mir-O-Col Alloy Co., Inc.*, 340 No. Avenue 21, Los Angeles 31., to expand its present production of precision steel and alloy castings.

Precision Castings Co., Inc. has acquired the *Bradley-Edlund Corp.* There will be no change in the active management of the corporation.

Purchase of the *Pacific Rivet & Machine Co., Alhambra, Calif.*, has been announced by *Milford Rivet & Machine Co.*, Milford, Conn.

The Engineering Development Div., Rheem Manuafacturing Co., has transferred its activities to P. O. Box 3669, Philadelphia 25.

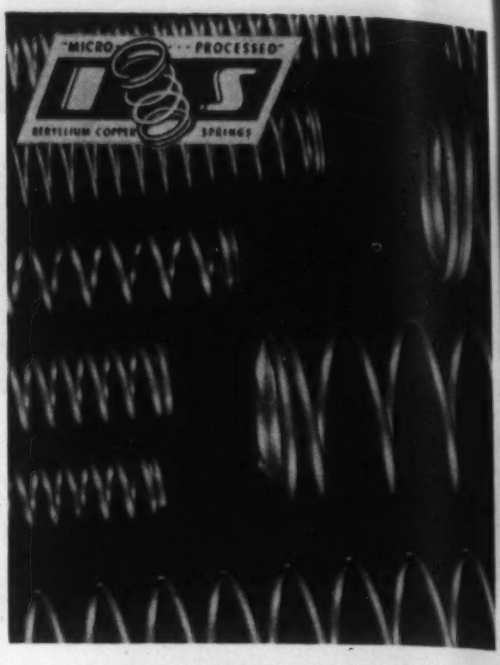
SKIL Corp. is the new name of *SKILSAW, Inc.*, according to a recent company statement.

Continental Can Co. has purchased a 40-acre plant site in Omaha, and will start construction of a modern, one-story plant for the manufacture of metal containers.

Ground was recently broken in Philadelphia for the *General Electric Co.'s* new $1,690,000 service shop and warehouse, designed to serve the growing industrial needs of metropolitan Philadelphia and the Delaware River Valley region.

Mullins Manufacturing Corp. has announced that it will establish the world's first plant for the cold extrusion of commercial items in steel under its Koldflo process. Cost of the new facility, to be part of its main Warren plant, will be $2,600,000.

A new company, *Eclipse Fuel Engineer-*



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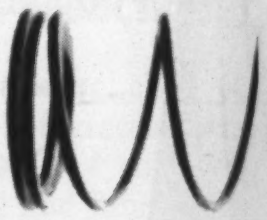

I-S Micro-Processed Beryllium Copper springs hold shape—dimensions and elastic properties 2 to 10 times more accurately than conventionally made springs.

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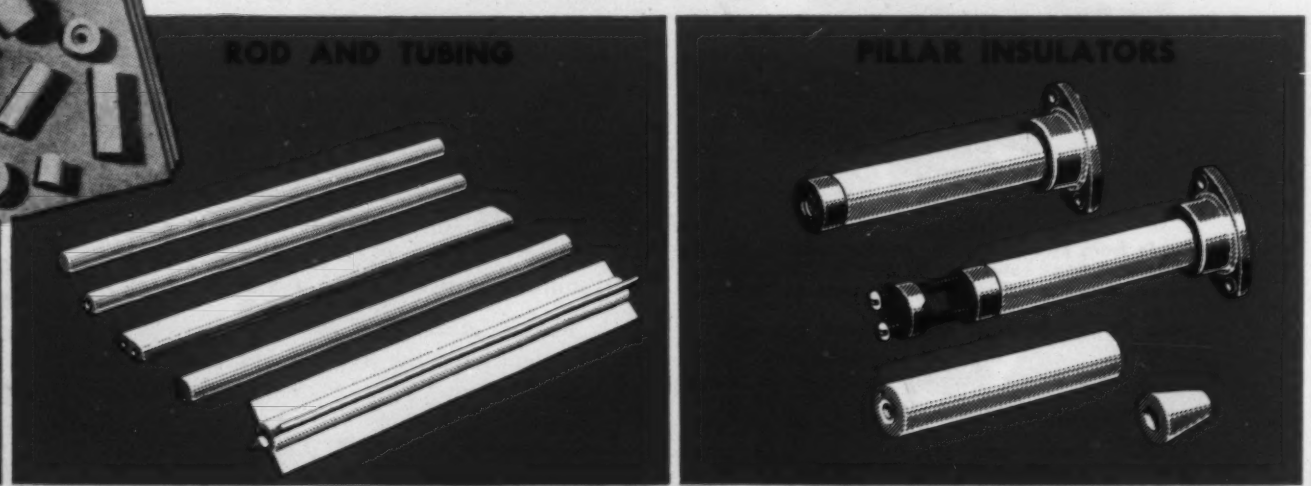

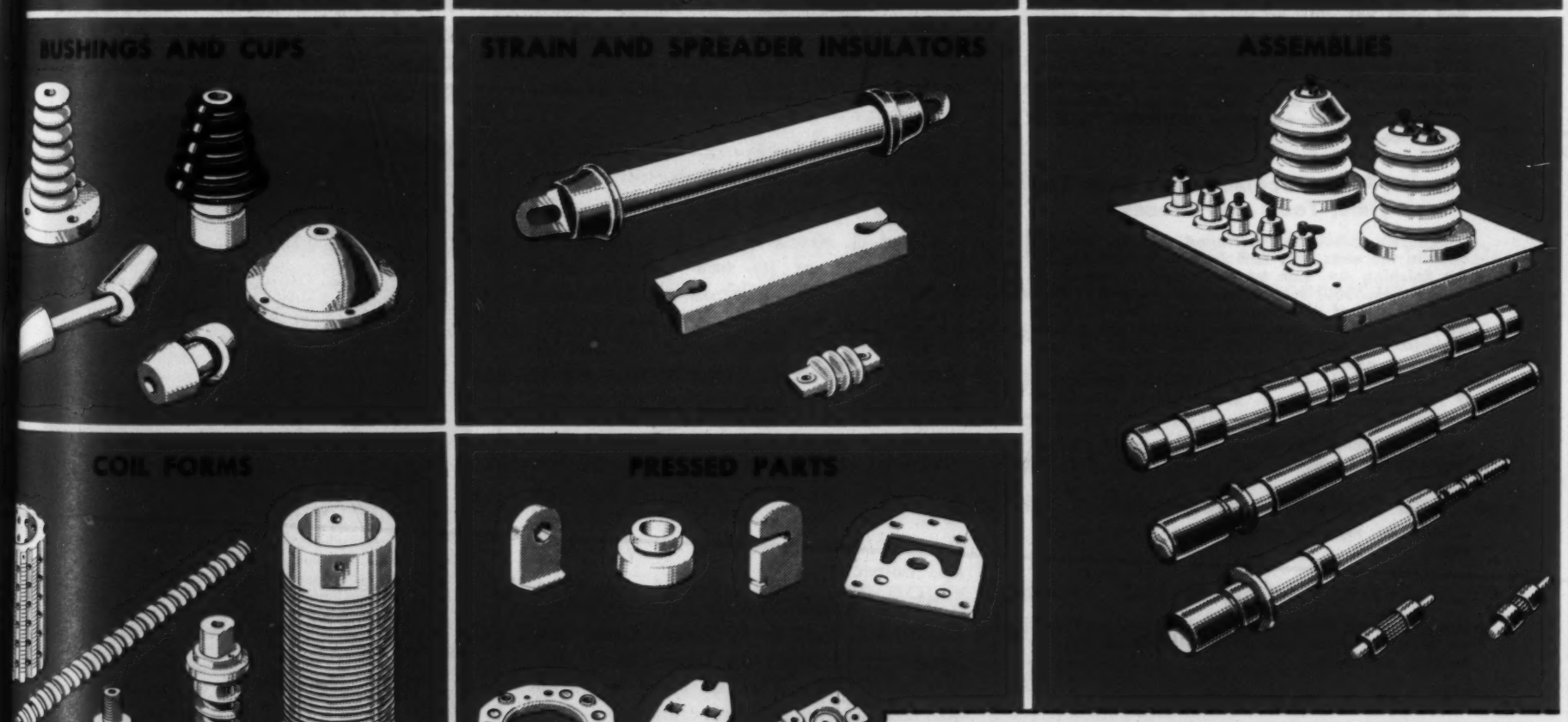

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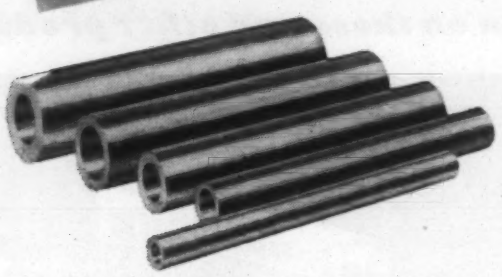

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Promet's High Safety Factor is Your Insurance Against Bearing Failure!

Tougher, harder and stronger, it resists shock loads and withstands high compressive forces and will not cut, or stick to the shaft under ordinary operating conditions. There is no seizing, no scoring—just smooth, quiet operation. Will not powder under the most severe conditions or service. When lubrication fails temporarily, Promet carries on safely until proper lubrication can be restored, affording protection against production shutdowns.

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Completely precision machined inside, outside and on the ends, yet sufficient stock remains for the finishing cut. Can be machined at speeds of more than 500 feet per minute—more than double those of phosphor bronzes. This complete machining insures you against subsurface defects sometimes found in rough cast bars. A considerable amount of metal has already been removed—metal which you would be purchasing if you used rough bars. Every bar is absolutely concentric.

Available round, hexagon and square, in 13-inch lengths, rough cast.

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of longer, superior service and lower maintenance cost.

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News Digest

ing Co., of Canada, Ltd., has been formed to handle sales and service on Eclipse products in Canada.

The National Research Corp. Scientific Trust has recently made the following grants for the support of research: Northwestern University, Dr. James N. Pitts, Jr., assistant professor, Dept. of Chemistry, "Photochemical Studies in the Far Ultraviolet and Schumann Regions," $4000; Rensselaer Polytechnic Institute. Kent D. Lawson, instructor, Physics Dept., "High Frequency Resonances in Ferrites," $3480; Rijks University, Leiden, Holland, Dr. Anton E. van Arkel, professor, Inorganic Chemistry, "Reactions of Halides or Oxides with Metals," $3125.

Metal Goods Corp. has announced the purchase of 17 acres of land to be used for a new plant site, located on the southside of 8900 Page Blvd., St. Louis.

Lindberg Engineering Co. has purchased 4½ acres of land adjoining the Southern Pacific Railroad tracks in Los Angeles. The company plans the building of a plant and offices for the manufacture of all types of heat treating and Lindberg-Fisher melting furnaces.

Kaiser Aluminum & Chemical Corp. has completed the first unit of one of the largest steam power plants in the world operated by a private industry for its own use. Power from this new 370,000-kilowatt steam plant at Kaiser Aluminum's Chalmette, La., reduction plant began flowing into the first of six new potlines it will serve to produce primary aluminum.

The Swedlow Plastics Co. has announced the opening of its third manufacturing facility in Los Angeles.

Claud S. Gordon Co. has announced the opening of its new manufacturing plant on a 6½ acre site at Richmond, Ill. Modern, new machinery has been installed for the manufacture of thermocouples, pyrometer accessories, specialty instruments and metallurgical testing machines.

Official opening of its new sales office, warehouse and service station in Birmingham, Ala., was recently celebrated by *Harnischfeger Corp.* with an open house and barbecue.

Walter Kidde Nuclear Laboratories has announced that it is establishing new laboratory facilities on Long Island, outside of Garden City to serve as headquarters for the firm's operations.

Reorganization of research activities of *Chase Brass & Copper Co., Inc.*, a subsidiary of *Kennecott Copper Corp.*, has resulted in the formation of a new *Research and Development Dept.*, to be headed by Dr. D. K. Crampton. The expanded research program is being housed in new quarters at the Chase Metal Works in Waterbury, Conn.

Formation of a new company, *Rutley*

the first PORTABLE superficial metal hardness tester!

DIRECT READING
ROCKWELL 15 N SCALE 70-95

. . . based on the same revolutionary ERNST principle as the famous ERNST portable testers being used in thousands of top-rated metal producing and fabricating plants.

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PEM Weld Fasteners are *all* you asked for to speed assembly, cut equipment and labor costs and do a better fastening job.

Write for literature, and samples for trial. Penn Engineering & Manufacturing Corp., Doylestown, Pa.

PEM

News Digest

Industries, Inc., 415 Greenwich St., New York City, has been announced. Headed by Charles A. Gerber and Arnold A. Tannenbaum, the company will have a staff of men qualified to analyze any metal finishing problem, prescribe the correct formula, and produce it in bulk for the user. In addition to consultation service and private production of special cleaning compounds, Rutley is manufacturing a standard line of preparations for sounder welding and brazing.

Kropp Forge Co. has announced the establishment of a new unit known as *Kropp Engineered Products,* specializing in the development of new and finished materials, as the latest step in the company's $5,000,000 expansion program. The new facility is located at 4701 W. 16th St., Cicero, Ill.

Ace Plastic Co. is currently building an extension to its building at 91-30 Van Wyck Blvd., Jamaica, N. Y. The extension is planned to enlarge the company's extrusion and fabricating departments.

Movement of manufacturing and assembly operations now at the *Detroit Lincoln* plant to the ultra modern *Lincoln-Mercury Div.* assembly plant nearing completion has been announced.

The *James F. Lincoln Arc Welding Foundation* has announced its Sixth Annual Engineering Undergraduate Award and Scholarship Program. Rules and Conditions booklet is available from the Foundation, Cleveland 17, Ohio.

Shenango Agaloy Tube Co. has announced the acquisition of *Koldweld Products, Inc.* The plant, newly located at Sharon, Pa., will be operated as a wholly owned subsidiary of Shenango Agaloy Tube Co.

Rezolin, Inc. has announced expansion of its facilities. The company has moved into larger quarters at 19368 James Couzens Highway, Detroit.

News of Societies

The leading metallurgical society of France, *la Societe Francaise de Metallurgie,* recently bestowed its highest honor on Dr. E. C. Bain, vice president, research and technology, U. S. Steel Co. Dr. Bain, the first American to receive the Grand Medal, has achieved international recognition principally for his work in the field of alloy steels.

One of the nation's highest honors has been awarded *Compressed Air and Gas Institute.* The honor referred to is the Award of Merit presented to the Institute in the 1952 ATAE Awards for Distinguished Service sponsored by *American Trade Association Executives of Washing-*

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ZINC with Luster-on® IS SUPERIOR TO CADMIUM for most industrial applications

Preconceived notions that cadmium plating just naturally offers better protection than zinc are contrary to the true facts. Simply because cadmium is freer again is no reason for re-converting to it. Cadmium is still and always will be far more costly than zinc. When the zinc is passivated in Luster-on conversion treatment it is far superior to cadmium for all but extremely specific applications. These are basically (1) a marine atmosphere and (2) a bearing surface.

FACT NO. 1

ZINC plus LUSTER-ON is DEFINITELY SUPERIOR TO CADMIUM IN AN INDUSTRIAL ATMOSPHERE.

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• HEAT RESISTANCE
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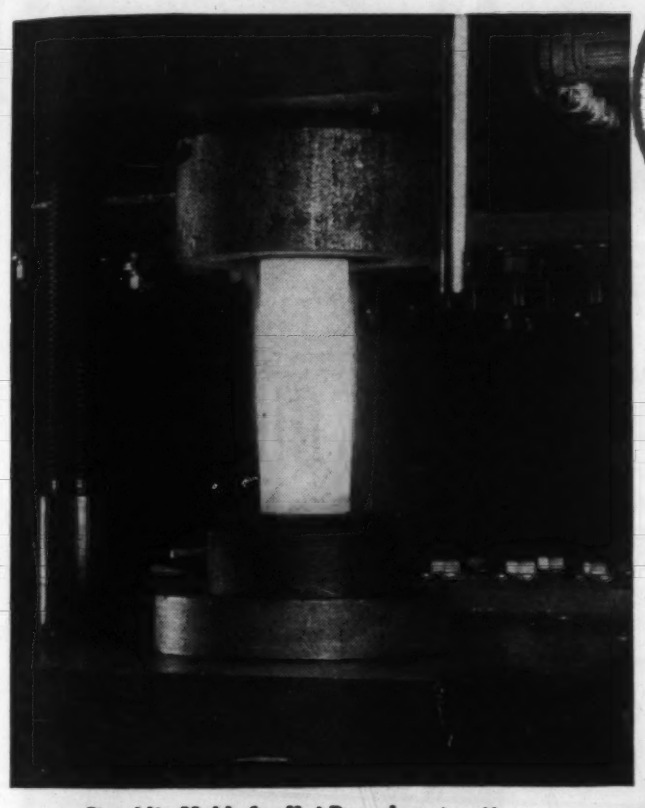
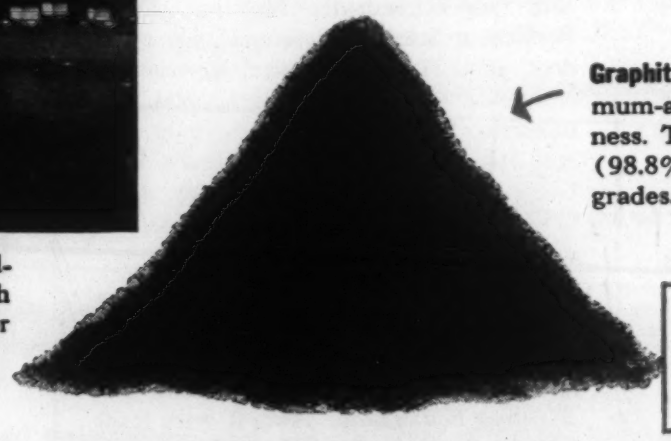


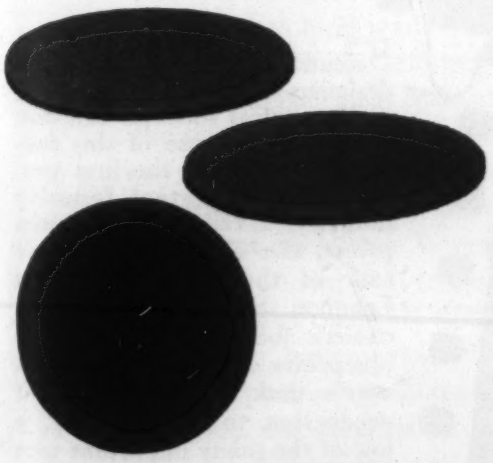
Graphite Molds for Hot Pressing. Available in all required high-strength grades, either as finished molds or as bar stock.

Wherever powders become parts, efficiently and profitably, a lot depends on electric furnace graphite in its various, accurately-controlled grades. Here, for example, are a few applications in which National Carbon's leadership in graphite research may handsomely reward your insistence upon the finest graphites obtainable.

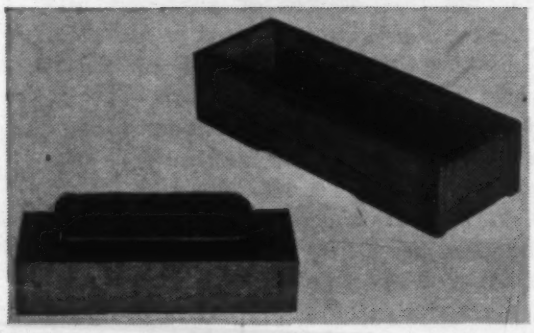


Graphite Powders. Guaranteed minimum-ash grades of specified fineness. Their electrographitic purity (98.8%) is unmatched by natural grades.

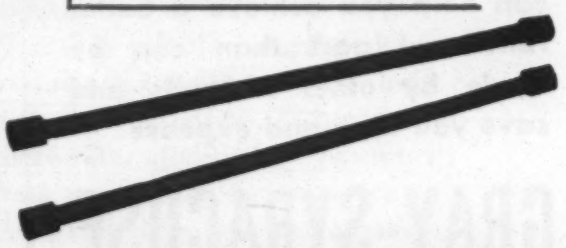
GRAPHITE COLLAR FOR WATER-COOLED COPPER CONNECTOR RING



Graphite Spacer Discs. Supplied in diameters up to 30", with accurately-ground parallel faces.



Graphite Sintering Boats. Machined from solid graphite stock to withstand temperatures over 3000 F without distortion. Extra high strength and ultra high purity grades to meet requirements.



Carbon and Graphite Tubes for Resistance Furnaces. Furnished "as extruded" or, where more uniform wall thickness is required, lathe-turned and bored from solid stock.

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. . . point to "Eveready" No. 1050 Industrial Flashlight Batteries . . . the cells that deliver twice as much usable light as any battery we've ever made before. Their unique construction prevents swelling or jamming in the case . . . has no metal can to leak or corrode.

The terms "National" and "Eveready" are registered trade-marks of Union Carbide and Carbon Corporation

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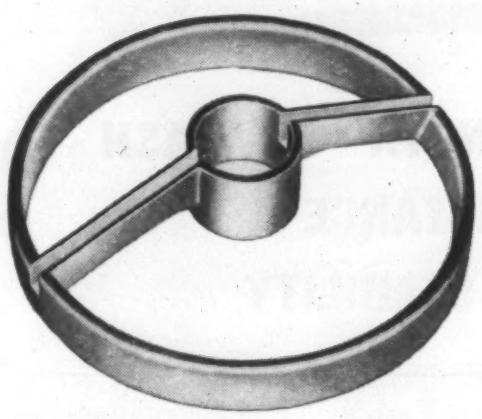
BRIDGING A PROBLEM!



Precision Investment Casting bridged this problem by making an integral unit of a costly machining and fabricating job. This process produces a part that is strong, accurate and with a good surface finish.

Precision Casting may also help you on your difficult small parts machining and assembly problems.

We are fully equipped to cast any ferrous or non-ferrous casting alloy you may desire.

Let our engineers see if they can help you achieve a better functional part than can be made by other methods and save you time and expense.

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News Digest

ton, D. C. The citation was presented to the Institute for its noteworthy services to its industry and especially for its education program centered on the schools of engineering and on the trade and technical press.

Northern Ohio Chapter, Society for Experimental Stress Analysis, has elected A. C. Gunsaulus and W. C. Johnson, Jr. to important posts. Mr. Gunsaulus was elected to succeed R. G. Anderson as chairman; Mr. Johnson was elected secretary-treasurer to succeed John R. Long. Named vice-chairman was George W. Bixler to succeed W. F. Brown.

L. F. Hickernell, chief engineer at Anaconda Wire & Cable Co., has been appointed chairman of the Technical Program Committee for the 1953 Winter General Meeting of the *American Institute of Electrical Engineers.*

John L. Young, vice president in charge of engineering, U. S. Steel Co., has been elected president of the *Association of Iron and Steel Engineers* for 1953. Other AISE officers for 1953 include: first vice president, E. L. Anderson, Superintendent. Electrical Dept., Bethlehem Steel Co.; second vice president, John H. Vohr, general superintendent, Gary Steel Works, U. S. Steel Co.; treasurer, W. H. Collison, assistant general superintendent, Blast Furnace Div., Great Lakes Steel Corp.; secretary, J. D. O'Roark, assistant to manager, service and maintenance, Weirton Steel Co.

Results of the fifth Annual Engineering Undergraduate Award and Scholarship Design Program have been announced by *The James F. Lincoln Arc Welding Foundation.* Awards were made for the best designs of machinery and structures stressing the value of arc welded construction. First award of $1129 went to Richard Cheverton and Thomas Musslewhite of Georgia Institute of Technology for their joint design of a subcalibre mount for a recoilless rifle. Merle Geoffrion, an undergraduate in the Civil Engineering Dept., University of Delaware, received the $564 second award for his design of a highway bridge. His Department received in his honor a scholarship fund of $500. Third award of $282 went to Robert Murray, a student in the Dept. of Architecture, Rensselaer Polytechnic Institute. His school was also awarded $250 in scholarship funds. Mr. Murray made an analysis to determine the economic span length of standard sections.

The American Welding Society has elected Fred L. Plummer, director of engineering, Hammond Iron Works, as its president for 1952-1953. Eric R. Seabloom, supervisor of field engineering, Crane Co., was elected first vice president; and J. H. Humberstone, vice president, Air Reduction Co., was elected second vice president.

Available for the first time... a Full-Color Sound Film

STEEL WITH A THOUSAND QUALITIES

Scientific schools and groups of designers, engineers, metallurgists and technical societies can *now* secure the *free* use of this full-color sound film, the first produced in the steel foundry industry. Available in 16 mm prints, the film is a 37-minute tour of the modern plant of Lebanon Steel Foundry. The camera follows jobs from the blueprints on the project engineer's desk through steps of production to show, finally, a few of the many important uses of Lebanon quality Steel Castings. Write for information on this exciting and educational film.

LEBANON STEEL FOUNDRY
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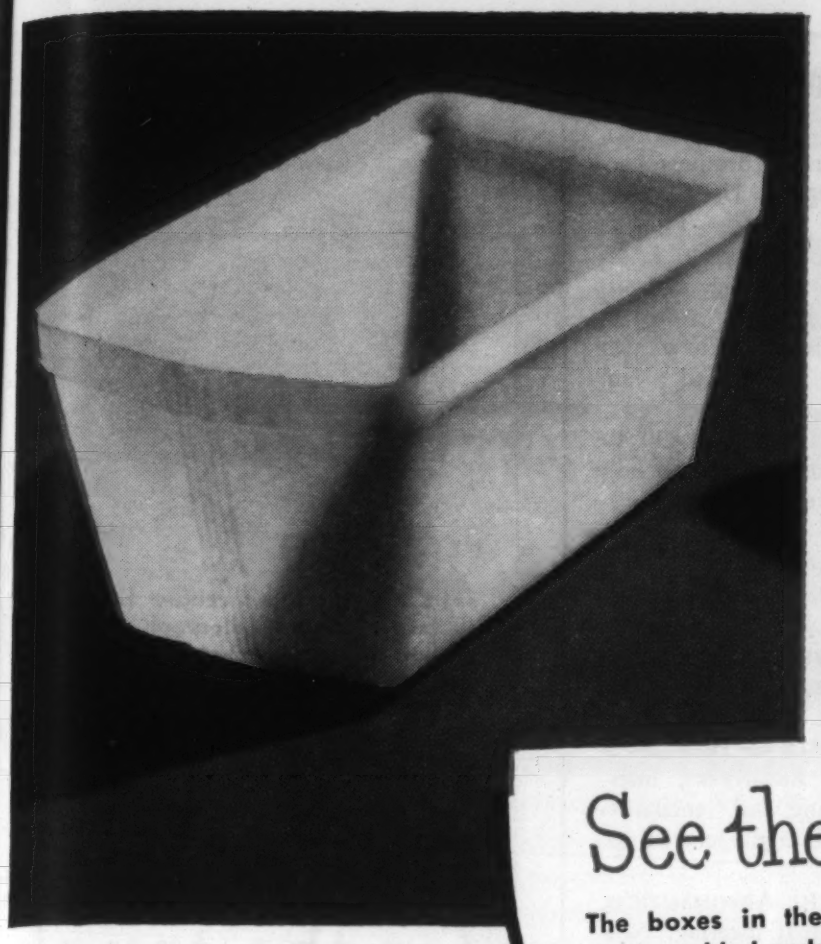
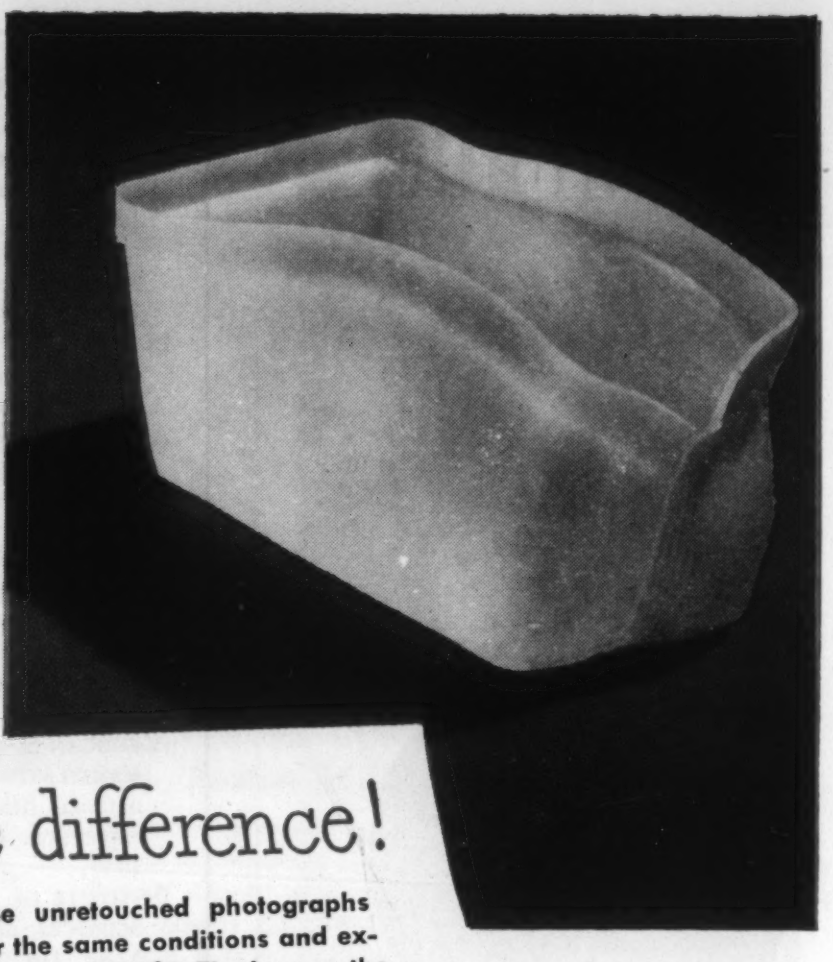
ALLOY AND STEEL
CIRCLE L **castings**





See the difference!

The boxes in these unretouched photographs were molded under the same conditions and exposed to a temperature of 212°F. The box on the left, made from Koppers MC 409, showed little or no distortion after 30 minutes at this temperature. The box on the right, made from a widely used commercial modified polystyrene, showed major distortion within 10 minutes.

high heat resistance in a modified polystyrene...

KOPPERS MC 409

• Here's the high-heat modified polystyrene that the industry has long wanted . . . Koppers MC 409.

This new material combines three important advantages . . . higher heat resistance *(up to 198°F.*)* . . . the toughness and shock resistance of modified polystyrene . . . and the desirable finish and molding characteristics of regular polystyrene. MC 409's excellent heat resistance is comparable to that of Koppers well known Polystyrene 8.

These qualities make MC 409 an ideal material for radio cabinets, battery cases, washing machine and refrigerator parts, toys, housewares, brush handles and, in fact, any molded or extruded polystyrene product subjected to heat.

Koppers MC 409 makes possible sturdy, shock resistant, plastic products that withstand the high temperatures found in show windows, dishwashers and automobiles, where other modified polystyrenes sag and shrink. Tests prove that on exposure to boiling water MM-122, will show low deformation with a minimum of shrinkage.

FOR FREE SAMPLES for testing in your laboratory and for Technical Bulletin C-2-161-TR describing the properties and characteristics of MC 409, write, wire or phone Koppers Company, Inc., Chemical Division, Dept. MM-122, Pittsburgh 19, Pa.

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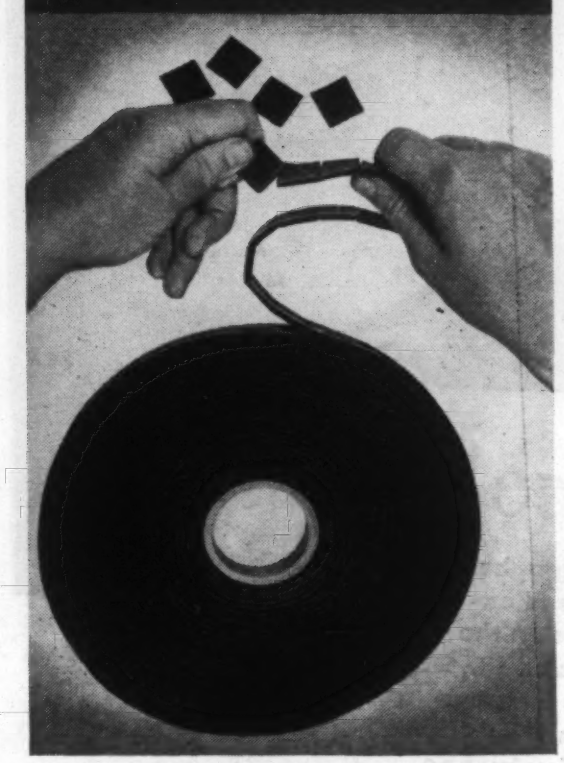

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Meetings and Expositions

INSTITUTE OF THE AERONAUTICAL SCIENCES, Wright Brothers Lecture. Washington, D. C. Dec. 17, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit. Jan. 12-16, 1953.

PLANT MAINTENANCE SHOW AND CONFERENCE. Cleveland. Jan. 19-22, 1953.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, winter general meeting. New York. Jan. 19-23, 1953.

SOCIETY OF PLASTICS ENGINEERS, INC., annual technical conference. Boston. Jan. 21-23, 1953.

MALLEABLE FOUNDERS' SOCIETY, general meeting. Cleveland. Jan. 23, 1953.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, international heating and ventilation exposition. Chicago. Jan. 26-30, 1953.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York. Jan. 26-30, 1953.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. Los Angeles. Feb. 16-19, 1953.

SOCIETY OF THE PLASTICS INDUSTRY, reinforced Plastics Div. meeting. Washington, D. C. Feb. 18-20, 1953.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting. Detroit. Mar. 2-6, 1953.

SOCIETY OF AUTOMOTIVE ENGINEERS, passenger car, body and materials meeting. Detroit. Mar. 3-5, 1953.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION, winter meeting. Chicago. Mar. 8-12, 1953.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS, annual conference. Kansas City. Mar. 15-19, 1953.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS, protective coatings symposium. Chicago. Mar. 16-20, 1953.

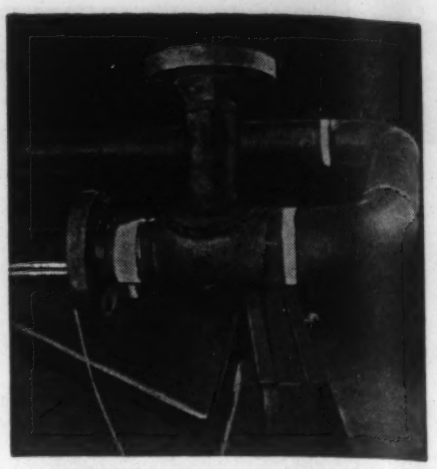
AMERICAN SOCIETY FOR METALS, Western metal congress and exposition. Los Angeles. Mar. 23-27, 1953.

MALLEABLE FOUNDERS' SOCIETY, market development conference. Ithaca, N. Y. Apr. 9-10, 1953.

INTERNATIONAL ACETYLENE ASSOCIATION, annual meeting. Atlanta. Apr. 13-15, 1953.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, open hearth and blast furnace, coke oven and raw materials conference. Buffalo. Apr. 20-22, 1953.

AMERICAN MANAGEMENT ASSOCIATION, annual packaging exposition. Chicago. Apr. 20-23, 1953.



Use RADIUM for the tough weld inspection jobs

THIS PHOTO shows radium being used to take a radium-radiograph of a weld. Placing the radium centrally in the pipe and the film on the outside (held in place by white tape) permits radiographing the entire circumferential weld with one exposure.

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1. **Portable**
2. **Easily handled**
3. **No training needed to operate**
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For the same reasons that radium-radiography has won nearly universal acceptance in steel foundries throughout the country, it is becoming the preferred means of inspection in welding shops.

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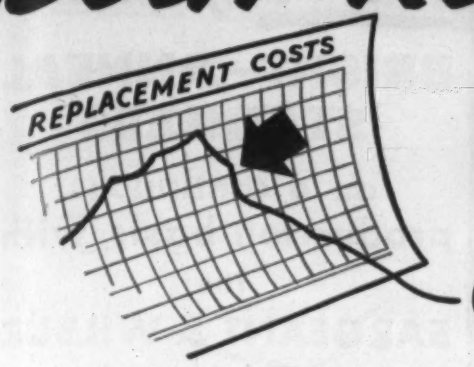

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Gun Iron is a super-refined iron, highly resistant to frictional wear, high heat, pressure, and erosion. It combines outstandingly those engineering properties that spell long, economical service.

You can rely on diesel parts cast of Gun Iron to serve you better longer, to provide high-measure protection against costly operating failures. That means more than worthwhile savings in replacements. It means longer periods of trouble-free, economical operation, one of the keys to more profitable operation. Today, in the face of equipment shortages, high maintenance costs, long economical service takes on added importance.

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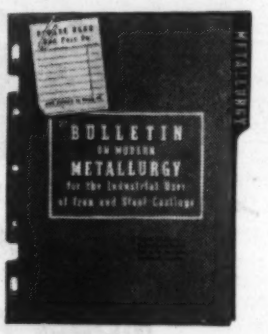
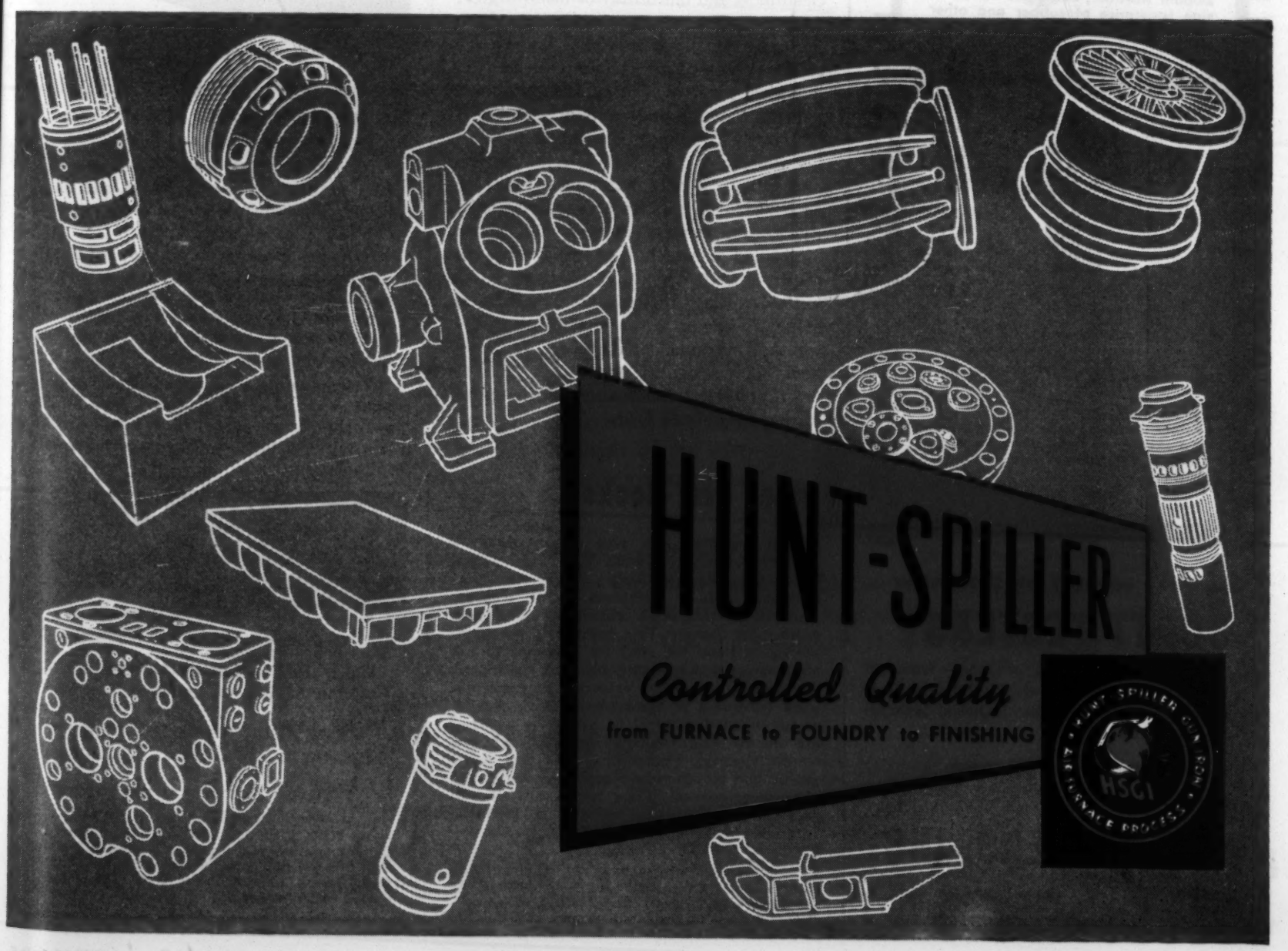
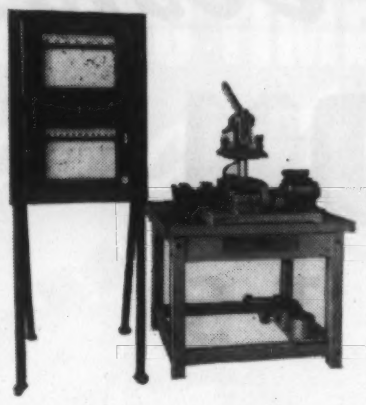


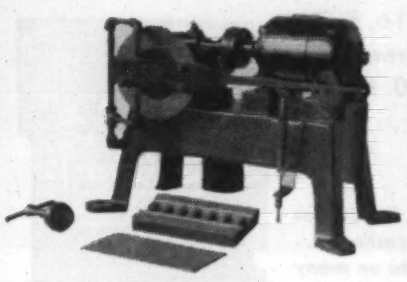
HERE IS A PRACTICAL GUIDE for the user of iron and steel castings . . . 24 pages of technical data on many types of metals and alloys. Write for your free copy.





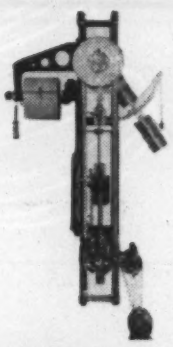
MODEL NBS

Mooney Viscometer, measures viscosity and scorch characteristics of crude or reclaimed natural or synthetic rubbers, their vulcanized compounds and similar elastomers.



MODEL A

Dupont Abrader, evaluates the abrasion resistance of rubber and other elastomers.



MODEL J-5

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BOOK REVIEWS

Investment Castings

INVESTMENT CASTINGS FOR ENGINEERS. *By Rawson L. Wood and Davidlee Von Ludwig. Published by Reinhold Publishing Corp., New York 36, N. Y., 1952. Cloth, 6 x 9 in.; 477 pages. Price $10.00.*

This book offers an unusually comprehensive description of the salient features, advantages and limitations of investment castings as they are now employed in the metal working industries. Emphasis throughout the work is on design engineering factors which determine the attainable precision of cast dimension, cleanliness and uniformity of metallurgical structure. The authors point out both present accomplishments and the considerations involved in developing further the industrial phase of investment castings.

Present design and metallurgical limits are clearly defined, as are the degrees of cast tolerance control now commercially obtainable. Recent techniques are also described in detail. Two chapters discuss the frozen mercury method, the entire mechanics of which have never been in print.

It is expected that this work will be of major assistance to all metallurgists, design and procurement engineers, foundrymen, tool designers, machinists, and to practically all technologists in the metal casting and related fields.

Other New Books

FERROMAGNETISM AND THE CURIE POINT—BULLETIN NO. 83. *By B. M. Aldrich. Published by The Oklahoma Engineering Experiment Station, Oklahoma A&M College, Stillwater, Okla., 1952. Paper, 6 by 8 in.; 42 pages. No charge.* This bulletin is prepared, having in mind the need for a review of the phenomena of ferromagnetism and to present the results of certain extended experimental work conducted in the field, to learn whether or not magnetism might be used as a material aid in the heat treatment of steel wherein certain allotropic changes are utilized to refine grains and to otherwise improve some of the physical properties. These test results, though proving negative, may serve as a guide to future investigations in this field.

TENTATIVE SPECIFICATIONS FOR COPPER AND COPPER-ALLOY WELDING RODS. *Published by the American Society for Testing Materials, Philadelphia, 3, Pa., and American Welding*

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Your samples processed free. If you want to see some of your own work bright-annealed, bright-hardened, or bright-brazed in a *conveyor furnace*, send us samples and specifications.

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Fuel injectors and carburetors for aircraft are mechanisms containing a variety of peculiarly shaped component parts. The usual procedure is to use hardenable, chrome stainless steels, Types 416 and 440F, which are most adaptable to easy machining. However, to save costs in machining from bars, stocks and forgings, Crucible applied Accumet Precision Castings. The close size control and good surface finish of the castings eliminate many costly machining operations — saving manpower, machine time and tooling expense.

more information available on castings

Long a leader in the development of precision investment castings, Crucible offers you the services of an alert metallurgical staff to help you profitably apply these specialty steels to your operation. Write us for more detailed information. CRUCIBLE STEEL COMPANY OF AMERICA, General Sales and Operating Offices, Oliver Building, P. O. Box 88, Pittsburgh 30, Pennsylvania.

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Accurate: 2 models — the 3 pound model measures loads to the nearest 1/100 ounce, and the 16 pound model to the nearest 1/5 ounce; lengths and deflections to 1/1000 inch.

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Book Reviews

(continued)

Society, New York 18, N. Y., 1952. Paper, 6 by 9 in., 13 pages. Price 40¢. The latest specifications for filler metal, issued jointly by the American Society for Testing Materials and American Welding Society (ASTM Designation B 259 and AWS Designation A5.7) covers copper and copper-alloy welding rods for use with oxyacetylene, carbon arc and inert-gas metal-arc (nonconsumable electrode) welding. The 12 classifications established by these specifications include copper, silicon bronze, phosphor bronze, copper-nickel, naval brass, manganese bronze, low-fuming bronze, nickel bronze and aluminum bronze welding rods.

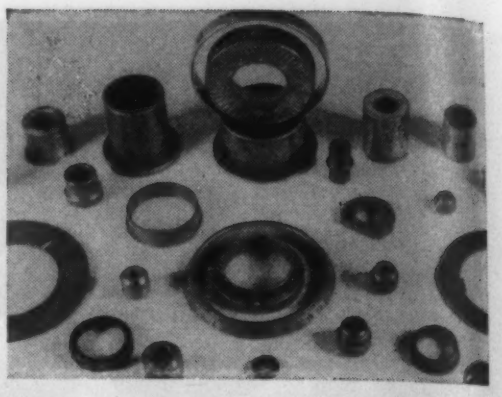
11-52T—Electronic Iron Core Preferred Dimensional Specifications. *Published by Metal Powder Association, New York 17, N. Y., 1952. Paper, 6 by 9 in., 4 pages. Price 25¢.* All of the types of electronic cores made from iron powders and commonly in use by the radio and television industries have been listed in this newly revised Standard. As revised, the Standard defines terms commonly associated with electronic cores made from powdered magnetic materials and specifies the preferred dimensions of standard sizes and shapes.

Progress In Metal Physics, Volume 3. *Edited by Bruce Chalmers. Published by Interscience Publishers, Inc., New York 1, N. Y., 1952. Cloth, 6 by 9¼ in., 334 pages. Price $8.00.* This is the third in a series to present authoritative reviews of the present state of knowledge in specialized aspects of the field that includes both physical metallurgy and metal physics. Such articles as: "Crystallography of Transformations"; "Properties of Metals at Low Temperatures"; "Recent Advances in the Electronic Theory of Metals"; "Twinning"; "Ferromagnetism"; "Quantitative X-Ray Diffraction Observations on Strained Metal Aggregates"; "Recrystallization and Grain Growth"; and "Structure of Crystal Boundaries" are presented here, along with helpful tabulated data.

Electronic Tubes in Industry. *By Keith Henney and James D. Fahnestock. Published by McGraw-Hill Book Co., Inc., New York 36, N. Y., 1952. Cloth 6 by 9 in., 353 pages. Price $6.00.* In the third edition of this book, the reader will find a helpful guide to the use of the electron tube in industry telling what the tube is doing toward making processes simpler, less expensive and safer, and how it can be applied in effecting new methods of manufacture. A clear explanation is found here of the principles of operation of the components, tubes and circuits applied to industrial problems of control, measurement, electronic heating, motor speed control and counting, sorting and grading. Amplifiers, thyratrons, phototubes and cathode-ray tubes and their many applications are described.

Writing the Technical Report. *By J. Raleigh Nelson. Published by McGraw-Hill Book Co., Inc., New York 36, N. Y., 1952. Cloth 6 by 9 in., 356 pages. Price $4.50.* This book is designed to give both students and practitioners a better understanding of the practical procedures involved in the preparation of a well-organized technical report. With emphasis on structural design, the book is less concerned with incidentals of form and convention than with basic principles and procedures. The author suggests a method of approach to the task of organizing and a method of production; sets up a few standards of criticism; and outlines certain simple critical procedures which the writer of such a report can apply to his work.

Physical Metallurgy for Engineers. *By Donald S. Clark and Wilbur R. Varney. Published by D. Van Nostrand Co., Inc., New York 3, N. Y., 1952. Cloth 6 by 9 in., 567 pages. Price $6.50.* The purpose of this work is to provide a text for engineering students who should receive a basic training in physical metallurgy as it applies directly to the selection, treatment and application of metals and alloys. Questions at the end of each chapter serve as an aid to the student in studying the material presented.

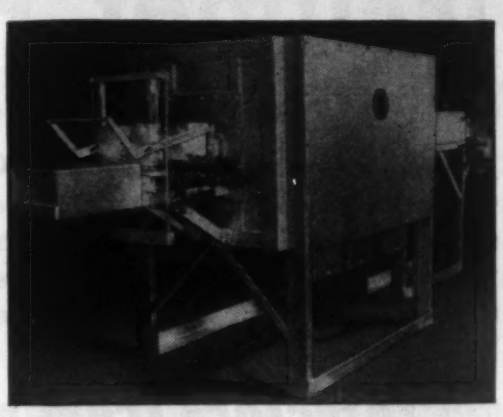


POWDERED METAL PARTS

Quickly & Economically Sintered in

Harper

Electric FURNACES



Model HOU-8436-MI-21 Harper Electric Furnace with cooling chamber for sintering, brazing, and annealing operations. Parts to be treated are charged and discharged manually in this alloy muffle furnace with water-cooled exit chamber. Simple sturdy construction of this unit, providing economy of atmosphere allows for maximum working at low investment cost.

Whether your heat treating requirements call for research or production units you will want to investigate the versatile features of Harper Electric furnaces for sintering metal powder products and other processes.

★ Unvarying electric heat assures a consistently, uniform product.

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★ Dependable control features allow heating schedules to be accurately maintained.

Write for full information,

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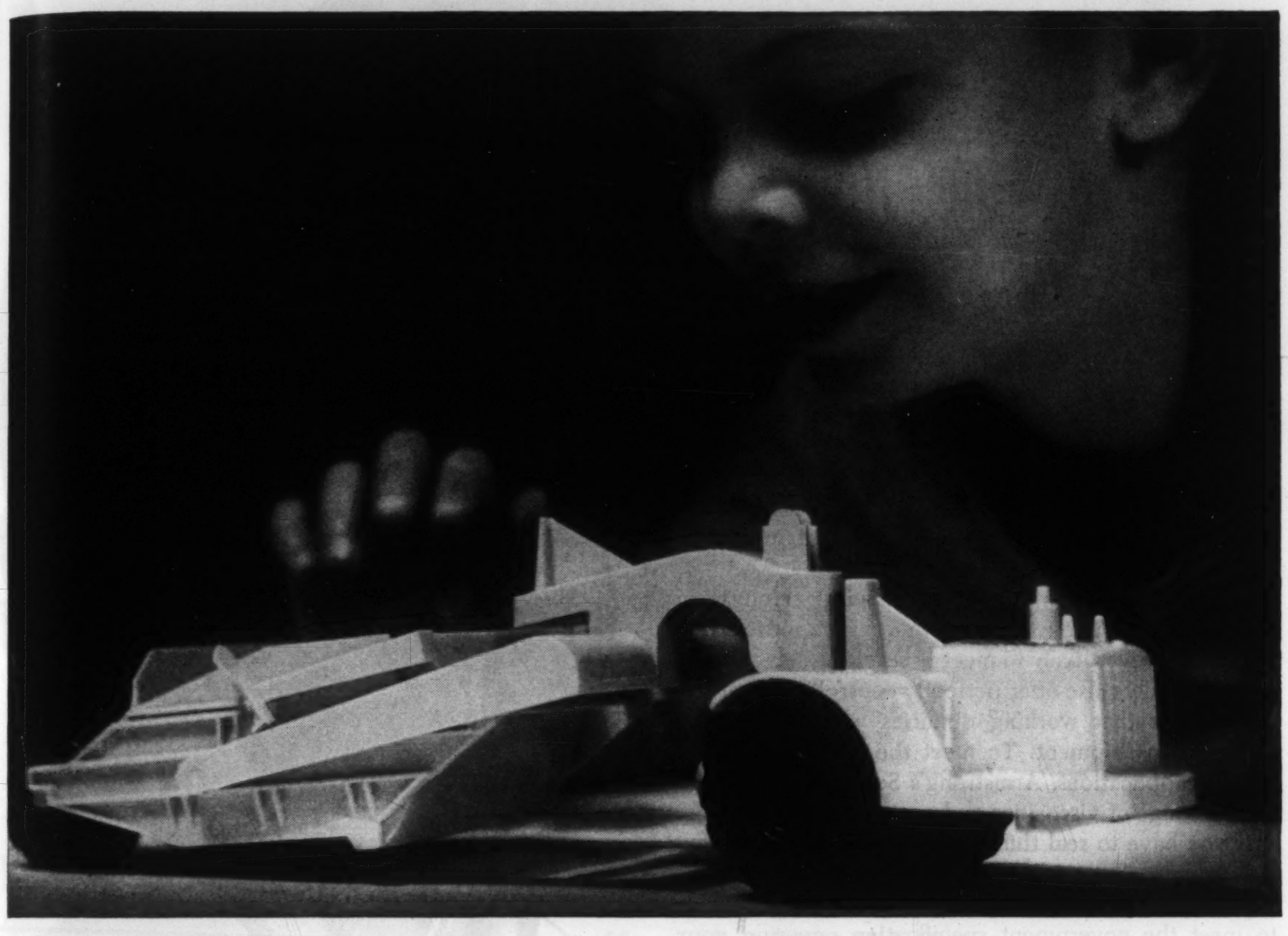
Dept. 6, 39 River St., Buffalo 2, New York

DOW



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to make true-to-detail

action toys *5 times tougher**

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*Quality-controlled Styron 475, on the basis of rigid laboratory tests averages five times the impact strength of general purpose polystyrene plastics and is lightweight, shock and moisture-resistant. It puts extra toughness into toys as well as numerous other products.

Perhaps plastics can improve your product, too. Why not work together with experts from Dow's Plastics Technical Service and an experienced molder to give your new product, or present ones, more buy-appeal at the point of sale? Write today. THE DOW CHEMICAL COMPANY, Midland, Michigan—*Plastics Department–PL 444D.*

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Tough defense jobs need tough sealers like these

Many defense jobs demand a sealer that's uniformly tough and free from shrinkage. For such exacting applications, Armstrong's Sealers are ideal.

Armstrong's Sealers can't shrink because they contain no solvents to evaporate. They're 100% solids. A chemical curing agent sets them after they're applied, by caulking gun or other device. This produces sealers that stay on the job wherever you put them; there's no shrinkage to break their grip.

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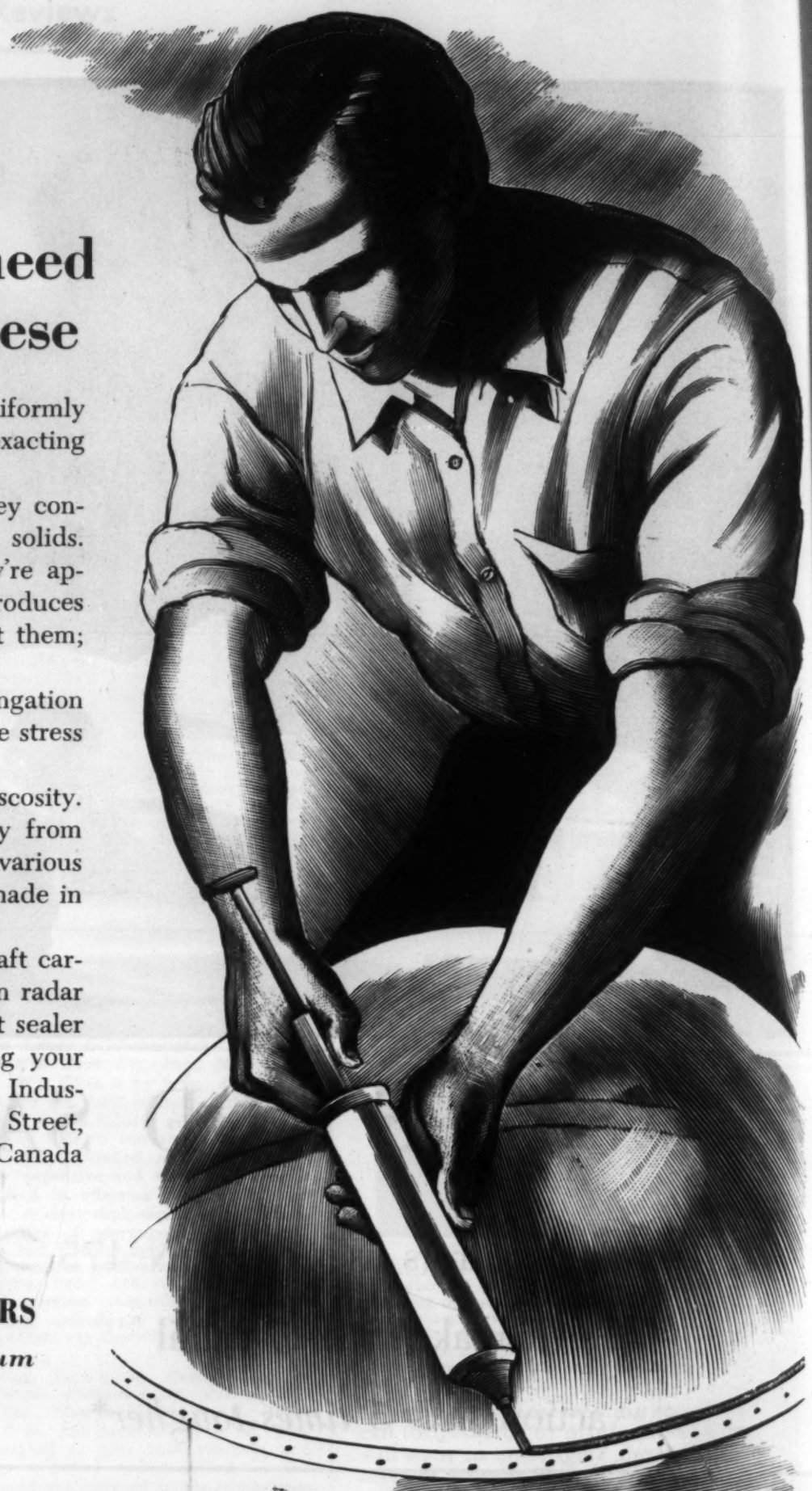
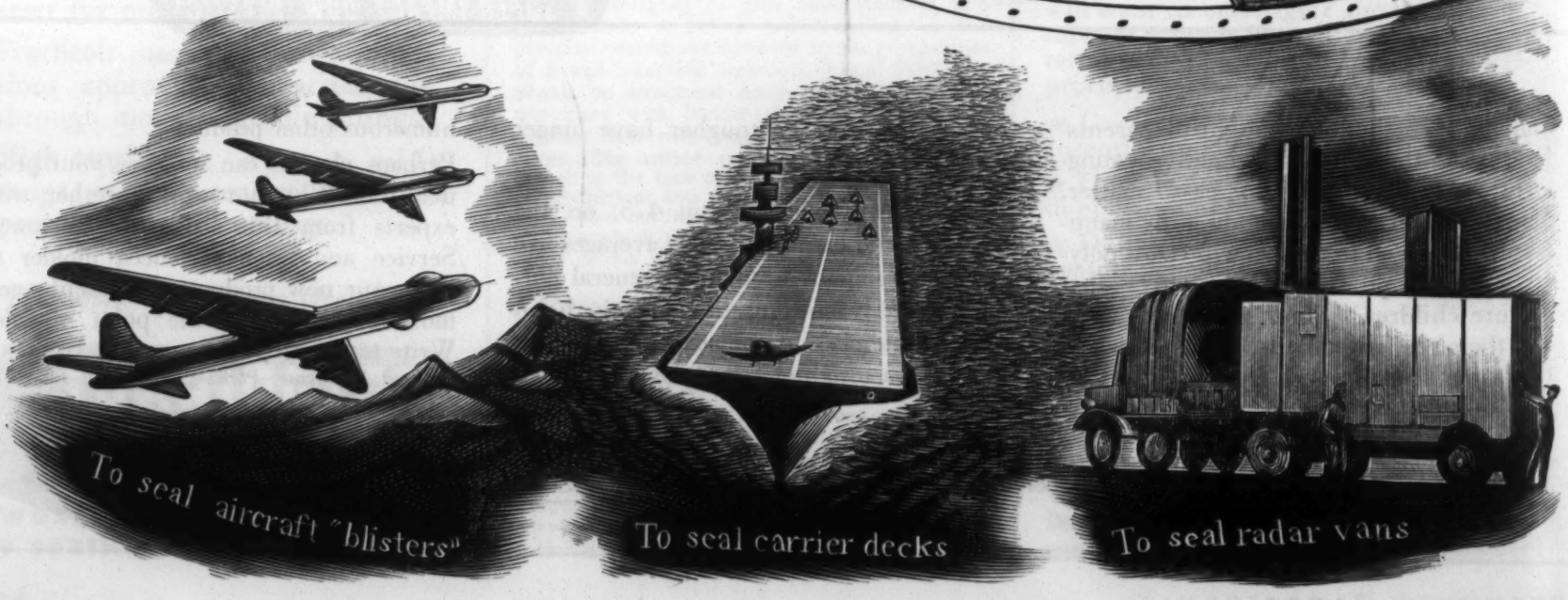
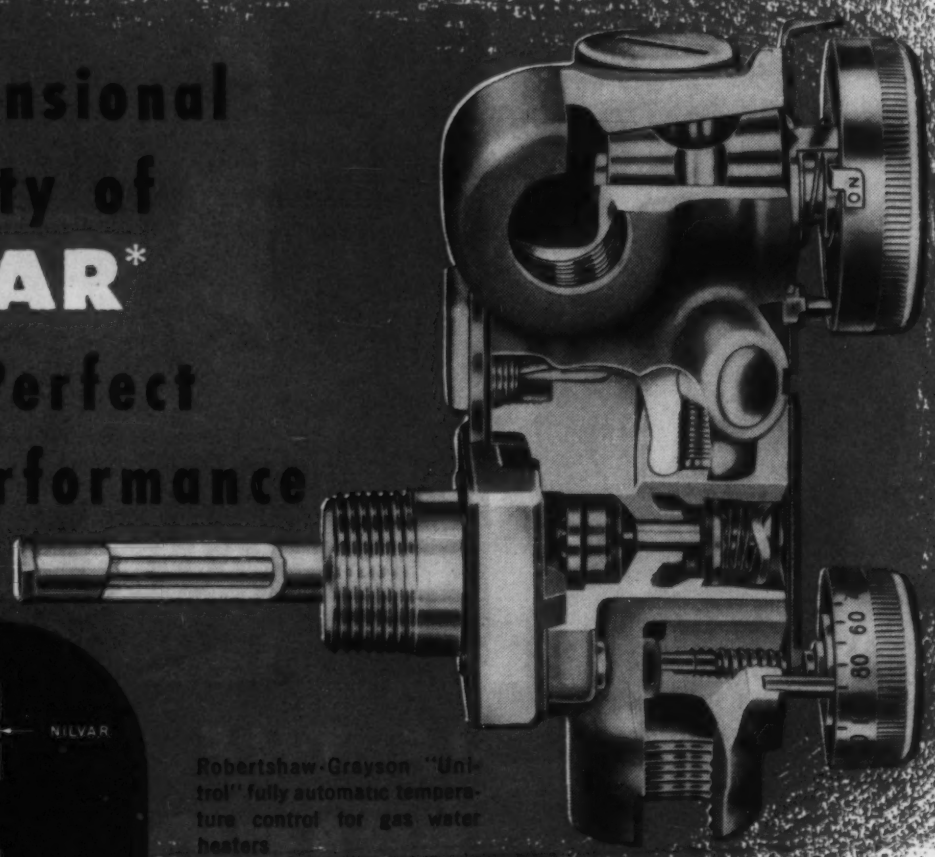


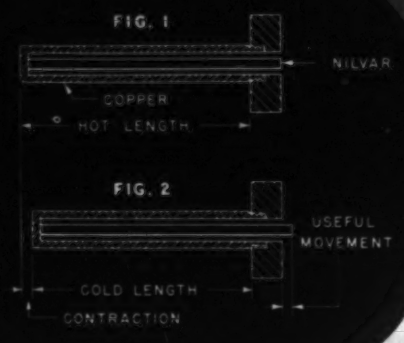


The Dimensional Stability of NILVAR* Spells Perfect Product Performance



Robertshaw-Grayson "Unitrol" fully automatic temperature control for gas water heaters

Schematic diagram shows how useful movement of Nilvar rod corresponds faithfully to the dimensional changes of the copper tube.



How Robertshaw-Fulton built a better Water Heater Control with Driver-Harris NILVAR

The new "Unitrol" Robertshaw-Grayson gas water heater control streamlines three essential controls into one valve body: a snap action thermostat, a snap action pilot, and a large-capacity gas cock. This reduces inventory for the water heater manufacturer and simplifies part stocking for the dealer.

The "Unitrol" provides a thermostat capable of delivering maximum amount of useful movement, by employing a copper tube enclosing a Nilvar alloy rod. The tube expands and contracts very appreciably in response to immersion temperatures. But the Nilvar rod, because it is dimensionally stable, does not vary in length. Since the free end of the Nilvar rod actuates the working gas valve, the slightest movement of the temperature-sensitive copper tube is fully utilized to control flow of gas to the burner.

Says Robertshaw-Fulton: "The outstanding dimensional stability of Nilvar actually permits minute changes in water temperature to regulate the heat supplied by the burner, thus assuring extremely accurate operation."

Nilvar has a temperature coefficient of expansion as low as .000001 per degree C., lowest of any alloy; comparable to that of quartz. Somewhere in your engineering operations such extraordinary dimensional stability may solve a problem—help to perfect product performance. We shall be glad to make recommendations based on your particular needs.

*T.M. Reg. U.S. Pat. Off.

Nilvar is produced only by

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Driver-Harris Company

HARRISON, NEW JERSEY

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In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario.

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can automatically finish your job faster, better or cheaper regardless of size, shape or material.

Murray-Way, "engineered-to-the-job", Micro-Polish equipment is now being used the country over in every type of application, on every conceivable kind of material.

Micro-Polish is an amazingly versatile and consistently successful automatic polishing method useful on any job from the prepolishing of low grade steel sheet, to meet high quality job specifications, to the production sharpening and polishing of pruning tools.

Micro-Polish can precision finish any size, shape or length of sheet, strip or blanked stock in ferrous or non-ferrous metals, wood, fiber, plastic, rubber or leather, by wet or dry process.

The typical Micro-Polish equipment shown here demonstrates how Murray-Way engineers have adapted the process to individual job requirements.

A Micro-Polish giant used in reclamation grinding of steel strip.

One of our smaller units used in polishing narrow bi-metal stock.

A versatile unit using belt conveyor to polish a variety of flat stampings and forgings.

A space saver unit for polishing flat bar stock. Two heads and two grades of belt grain accomplish the complete job without rehandling.

Murray-Way engineers will gladly show you how this time and cost saving method can improve your polishing operation.

MURRAY WAY

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POTASSIUM TITANIUM FLUORIDE

To serve the growing needs of the light metal industry, Baker & Adamson has recently inaugurated commercial production of high-purity Potassium Titanium Fluoride at its B&A Works, Marcus Hook, Pennsylvania. This marks another step forward in B&A's long-term program for the production of a wide range of inorganic fluorides in tonnage quantities.

For more than two decades Baker & Adamson has conducted extensive research in the field of fluorine chemistry. Today, it is geared to produce virtually any inorganic fluorine chemical that Industry might require. Listed below are the many fluorine compounds B&A now offers in commercial quantities. Many others are in the development stage.

If your present or projected operations call for Potassium Titanium Fluoride, or any of the other products listed below, make B&A your source.

For further information, check those that interest you and return the coupon clipped to your company letterhead.

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- ☐ Hydrofluoric Acid

ACID FLUORIDES
- ☐ Potassium Bifluoride

ALKALI FLUOBORATES
- ☐ Ammonium Fluoborate
- ☐ Potassium Fluoborate
- ☐ Sodium Fluoborate

ALKALI FLUORIDES
- ☐ Potassium Fluoride

DOUBLE FLUORIDES
- ☐ Potassium Chromium Fluoride
- ☐ Potassium Titanium Fluoride

METAL FLUORIDES
- ☐ Aluminum Fluoride, Cryst.
- ☐ Chromium Fluoride
- ☐ Copper Fluoride

METAL FLUOBORATE SOLUTIONS
- ☐ Copper Fluoborate
- ☐ Ferrous Fluoborate
- ☐ Indium Fluoborate
- ☐ Lead Fluoborate
- ☐ Nickel Fluoborate
- ☐ Stannous (Tin) Fluoborate

NON-METAL FLUORIDES
- ☐ Boron Fluoride Gas
- ☐ Boron Fluoride-Diethyl Ether Complex
- ☐ Boron Fluoride-Phenol Complex
- ☐ Sulfur Hexafluoride

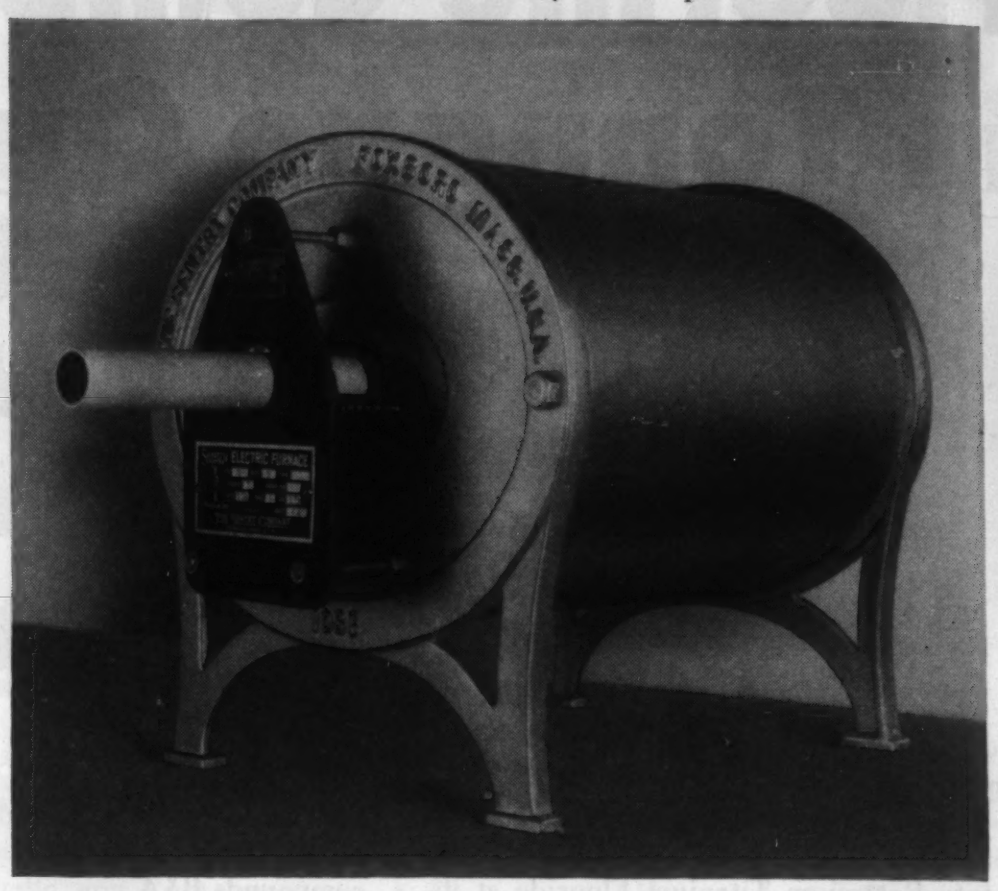
HALOGEN FLUORIDES
- ☐ Chlorine Trifluoride

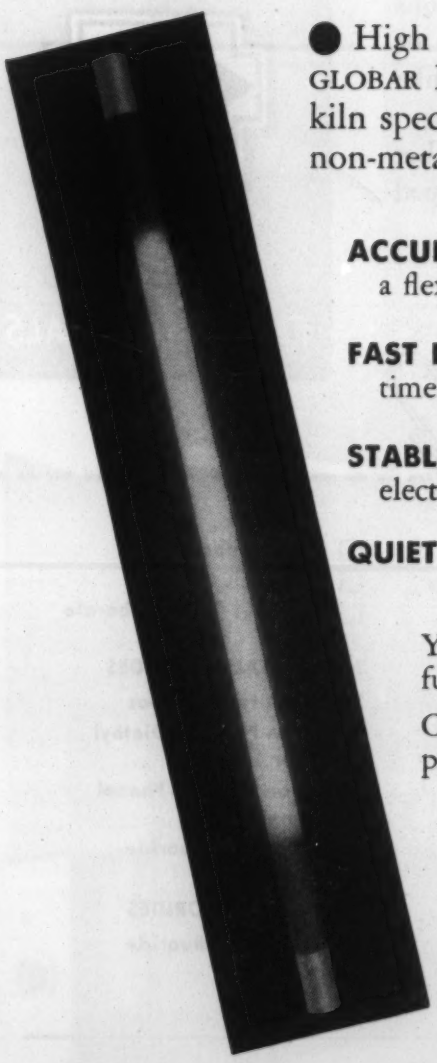
Name_____ Title_____

Company_____ Address_____ MM-12

How GLOBAR TRADE MARK Heating Elements solve high temperature problems

● This Sentry Model V Combustion Furnace, designed primarily for fast carbon determinations in steel, uses GLOBAR heating elements for quick, even, clean heat. A companion furnace, Model VV—with two combustion tubes—is also manufactured by The Sentry Company, Foxboro, Massachusetts. Write to Sentry for complete information.





● High temperature problems disappear when engineers and designers turn to GLOBAR Brand silicon carbide heating elements by CARBORUNDUM. When furnace and kiln specifications call for temperatures up to 2750°F, they specify GLOBAR non-metallic electric heating elements because they offer:

ACCURATELY CONTROLLED HEAT—With a flexible range of temperatures.

FAST HEATING-UP TIME—To cut operating time and costs.

STABLE, UNIFORM HEAT—Because it is electric.

QUIET HEAT—No blower or burner noise.

SAFE HEAT—No explosion hazard, no expensive exhaust systems needed.

CLEAN HEAT—No fumes, no dirt.

LONG, TROUBLE-FREE SERVICE—No moving parts to get out of order.

EASY REPLACEMENT OF ELEMENTS when necessary—No dismantling of furnace or kiln, no extended production delays.

You can put these time and money saving advantages to work for you, if you use furnaces equipped with GLOBAR heating elements.

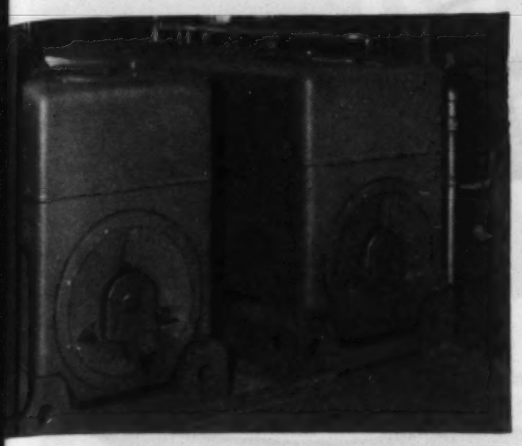
Our engineers will be pleased to work with you in solving any high temperature problems. Just write complete details to Dept. MM 87-125.

GLOBAR Heating Elements TRADE MARK by CARBORUNDUM

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company, Niagara Falls, New York

87-125

G-E induction heating, with controls mounted above the motor-generators, saves plant space at the forging machines



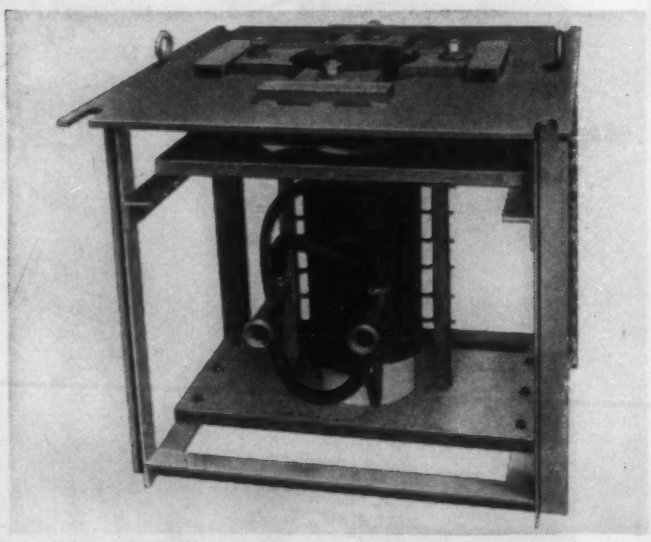
2 Power for heating is instantly ready from these 3000-cycle units. Enclosed construction permits location right at the job.

3 Only the portion to be upset is heated, saving power and minimizing radiation. Heating time for each end of these truck axle housings at Clark Equipment Co., Buchanan, Mich., is only 55 seconds.

Why You Should Use Induction Heat for Forging

4 Only two induction heaters supply heated housings for a production rate of one housing every 30 seconds from this upsetter.

5 Different sizes of housings are accommodated by an easy change of the inductor coil assembly.



6 With G-E induction heat, minimum scale is formed, and therefore *die life is increased.*

LEARN MORE about how G-E induction heating equipment can do selective heating for heavy jobs like these axles. Call the nearby G-E Sales Office for the Industrial Heating Specialist . . . an expert on applying induction heating equipment. For bulletin GEA-5679, EQUIPMENT FOR INDUCTION HEATING—1, 3, 10 kilocycles, send in this coupon.

( ) for immediate project ( ) for reference

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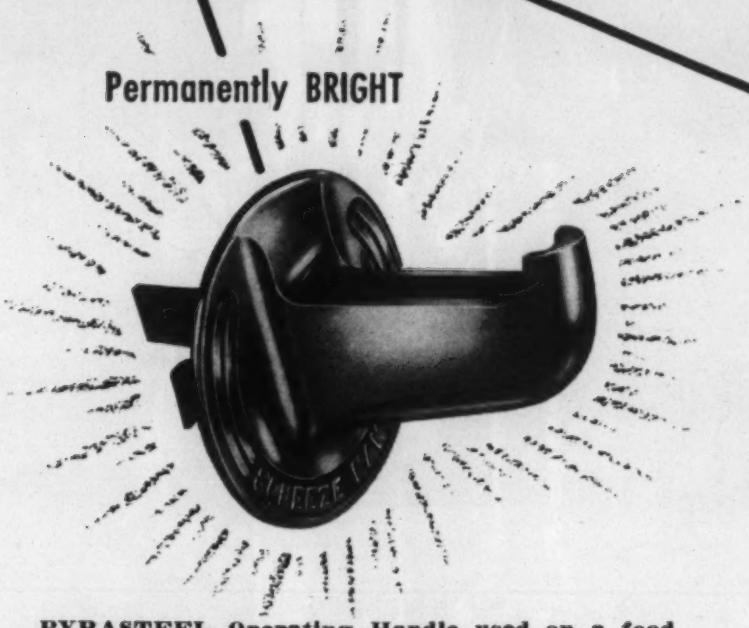
GENERAL ELECTRIC

PYRASTEEL *Alloy* Steel PARTS

for producing a lasting finish

Permanently BRIGHT



PYRASTEEL Operating Handle used on a food vending machine.

The manufacturer tried a number of materials, but the handle would soon become discolored from use.

Then PYRASTEEL was employed for casting these units—result: the highly polished surface remains impervious to stain or wear under all conditions of service.

Write for PYRASTEEL Bulletin

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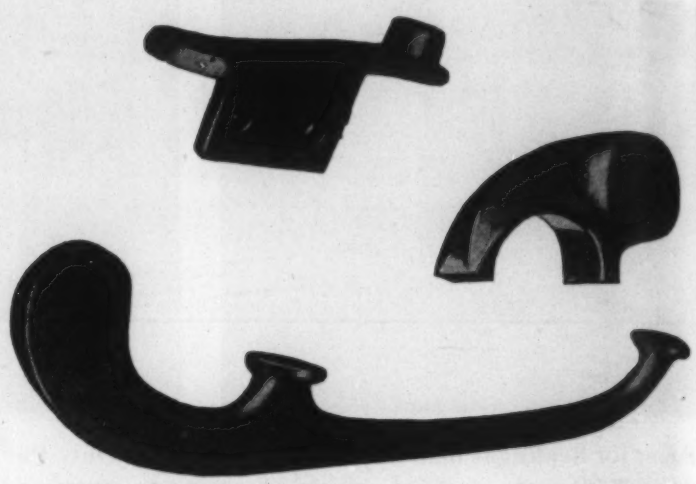

PYRASTEEL Stainless Parts are essential in many applications for modern food processing equipment.

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5. Replace shot or sandblasting for scale removal.
6. Clean and brighten automotive and airplane parts.
7. Salvage iron and steel parts rusted by fire or flood.
8. Remove oil quenching scale and smut electrolytically in bulk.

Write for bulletin describing the many features of this new Alkaline Derusting Process.

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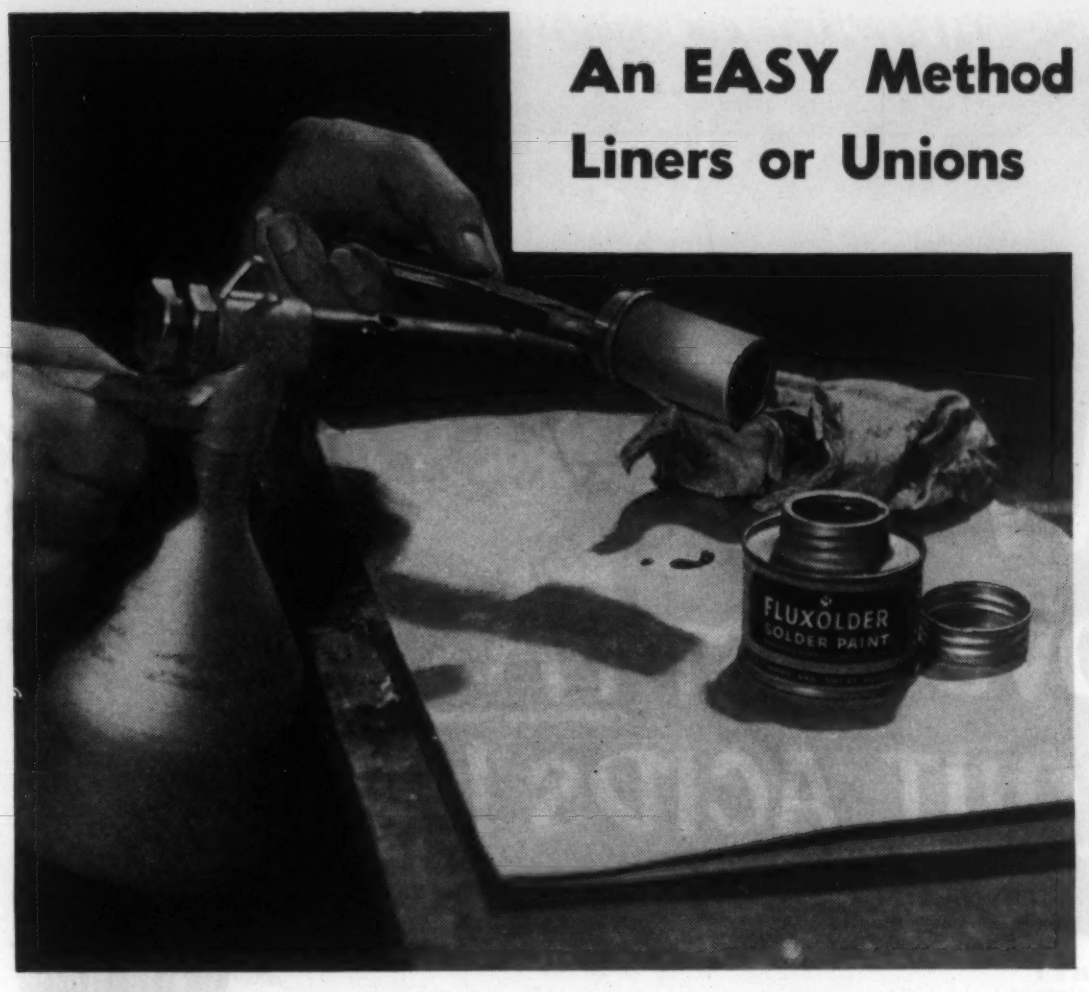

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The operation of tinning brass liners or unions is often, as shown in the illustration, carried out by means of a blowtorch flame and Fluxolder Solder Paint. This provides a convenient and rapid method of tinning brass liners or ends of copper tubes to be jointed or soldered. The flux in the paint is sufficiently active to insure adequate removal of surface oxide, thus insuring proper tinning. The joint strength is identical with that of stick solder.

FLUXOLDER simplifies tinning and soldering. Saves time and solder. It is suitable for all metals other than aluminum.

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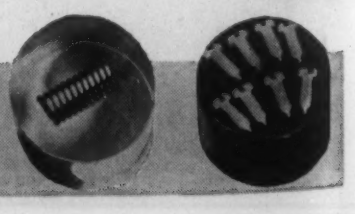
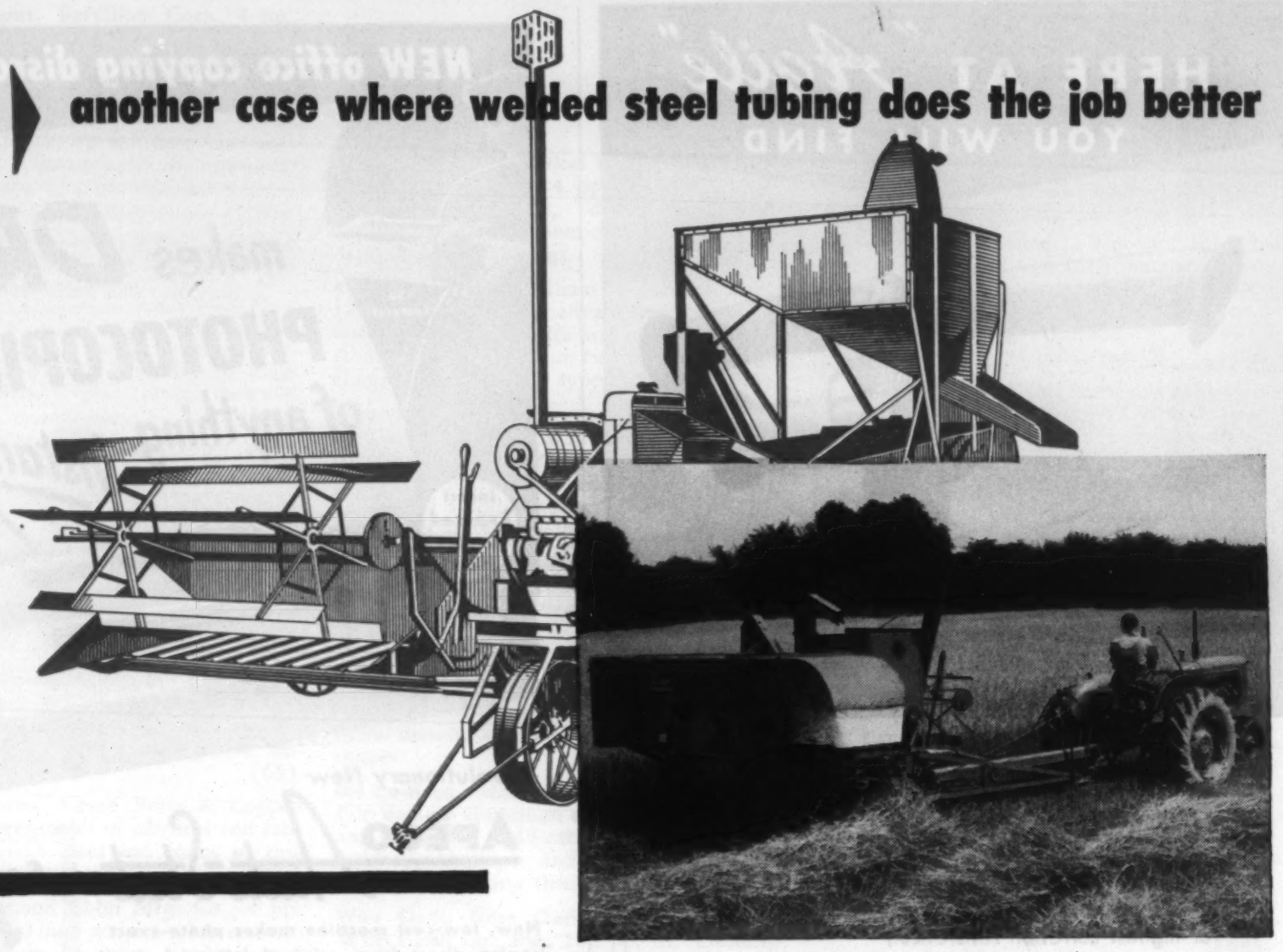
165 West Wacker Drive, Chicago 1, Illinois



another case where welded steel tubing does the job better



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it can do the same for you . . .

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Strength and shock resistance were increased because Republic ELECTRUNITE Steel Tubing provided maximum strength per pound of metal over ordinary conventional shapes. Troublesome torsion and weaving of implements on rough ground was cut drastically . . . useful life of the implements was greatly lengthened, and maintenance reduced.

Does this give you some ideas about *your* product . . . whatever it may be? Republic ELECTRUNITE Steel Tubing can keep your product strong yet make it lighter, make it better at lower cost, more attractive to the man who uses it . . . and who buys it. We'd like to tell you our ideas.

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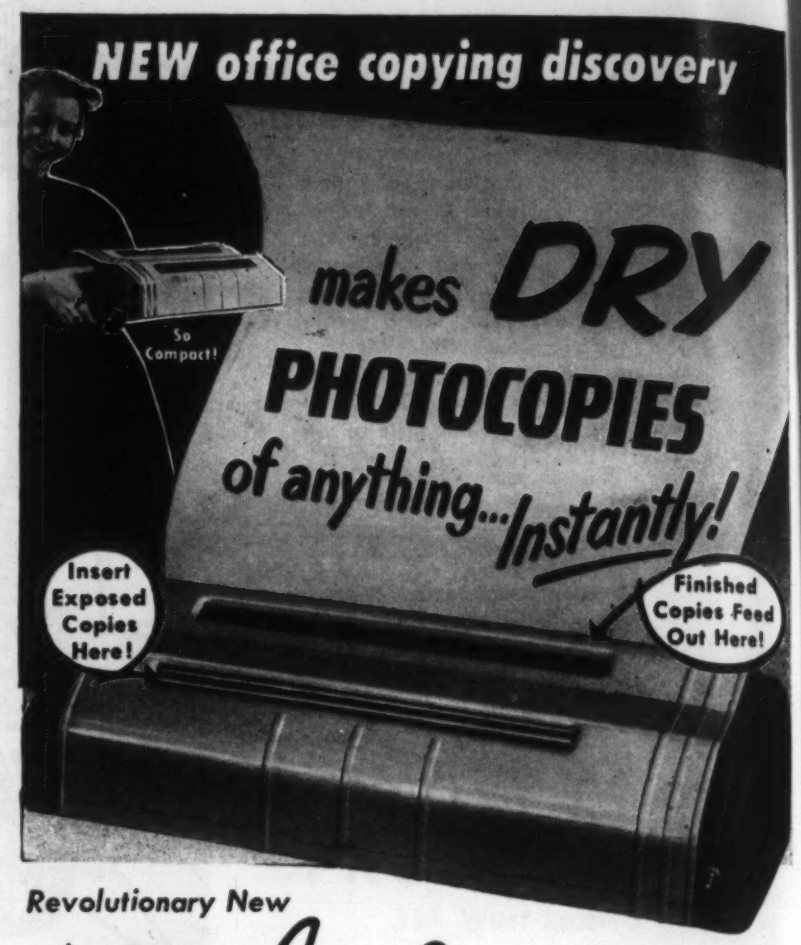

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Here is the first major advancement in office copying in the last 15 years. Can save you up to 80% on your copying jobs! Eliminate costly retyping, hand copying, checking or sending outside for expensive copying service. The Auto-Stat is the first low-cost machine that makes error-proof, legally-accepted, black-and-white *photo-like* copies—WITHOUT SLOW, MESSY DEVELOPING, FIXING, WASHING OR DRYING. It's fast—only 2 simple steps instead of 12 required by old methods. Makes prints instantly from any originals up to 11 x 17 inches—whether printed on one or two sides. Requires no dark room—and any inexperienced clerk can operate it!

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MANUFACTURERS' LITERATURE

Metal Diaphragms. Beryllium Corp., 4 pp, ill. Helpful facts about selection of material, tooling methods, heat treating and testing procedure of beryllium-copper diaphragms. (59)

Shell Molding. The Borden Co., Chemical Div., 8 pp, ill. Describes the shell-molding process, its advantages, the equipment used, and gives historical background. (60)

Grain Size. Bridgeport Brass Co., 4 pp, ill. Photomicrographs illustrate how grain size is affected by annealing and cold rolling. (61)

Magnesium. Brooks and Perkins, Inc. "Focus on Magnesium" has table of magnesium alloy characteristics, design data and applications. (62)

Permanent Magnets. Carboloy Dept., 19 pp, ill, No. PM100. Brief description and specifications of various types of Alnico permanent magnets. (63)

Punch and Die Setting Alloy. Cerro de Pasco Corp., 20 pp, ill, No. A15. Properties and description of use of Cerromatrix for setting various types of dies and punches. Shows advantages over solid dies. (64)

Thermostatic Bimetal. W. M. Chace Co., 4 pp., ill, No. 1 a/.10. Properties of thermostatic bimetals and formulae to use in application to temperature responsive devices. (65)

Phosphor Bronzes. Chase Brass & Copper Co. Folder gives tables of physical and fabricating properties, uses and forms of this company's phosphor bronzes. (66)

Rhodium. Sigmund Cohn Mfg. Co., 4 pp. Properties of rhodium and its value in electroplating due to its color, hardness and high corrosion resistance. (67)

Copper-Base Alloy Rod. Copper & Brass Research Assn., 30 pp, ill. Attractive handbook provides pertinent data about free-cutting brass and other copper-base alloys in the form of rod for screw machine products. Includes numerous drawings and tables. (68)

Aluminum Bronze. Dirilyte Co. of America, Inc., 12 pp, ill. Physical properties and specifications of Molin Metal, pure aluminum bronze for quality castings. (69)

Die Cast Parts. Dollin Corp. Bulletin describes advantages of using this company's facilities for production of small zinc or aluminum precision cast parts. (70)

Nickel Alloy Products. Driver-Harris Co., 4 pp, ill. "D-H Alloy Craftsman" describes various applications of Nichrome and monel wires and forms. (71)

Magnesium and Aluminum Castings. Eclipse-Pioneer Div. Foundries. "Book of Facts" shows this company's facilities for custom-making aluminum and magnesium castings. (72)

Metal and Plastics Parts. The Electric Auto-Lite Co., Bay Mfg. Div., 16 pp, ill. Shows wide variety of custom-made ornamental and functional metal and plastics parts. (73)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. G137. Describes facilities for economical manufacture of quality die castings. (74)

Aluminum Alloy. Frontier Bronze Corp. Data on Frontier 40-E aluminum alloy combining high strength, good shock and corrosion resistance and machinability. (75)

Laminated Metals. General Plate Div., Metals & Controls Corp., 4 pp, ill, No. 1A. Properties and uses of various laminated metals, including precious metals overlays and laminated silver contacts. (76)

Beryllium-Copper Electrical Parts. Instrument Specialties Co., Inc., 4 pp, ill, Nos. B-52, C-52. Specifications, descriptions and dimensions of beryllium-copper grounding strips and contact rings. (77)

Aluminum Alloy. William F. Jobbins, Inc., 12 pp, ill. Includes advantages, composition, physical properties and applications of Almag 35, an aluminum casting alloy of the aluminum-magnesium types. (78)

Aluminum Sheet Fabrication. Kaiser Aluminum and Chemical Sales Inc., 3 pp. Chart suitable for posting in shops indicates minimum recommended radii for the proper bending of aluminum sheet. (79)

Cemented Carbides. Kennametal Inc., 16 pp, ill. A comprehensive and useful booklet containing complete data on the characteristics of Kennametal cemented carbides. (80)

Tungsten Carbide Parts. Metal Carbides Corp., 68 pp, ill, No. 50-G. Descriptions, specifications and prices of standard Talide Metal dies, rolls, bushings, forms and special shapes. (81)

Die Castings. Monarch Aluminum Mfg. Co. File data on aluminum and zinc die castings and aluminum mold castings showing applications, advantages and this company's facilities for making them. (82)

Wire Cloth, Filter Cloth, Etc. Multi-Metal Wire Cloth Co., Inc., 126 pp, ill. Contains specifications, characteristics and uses of wire cloth, filter cloth and fabricated products. (83)

Bronze and Babbitt Metals. National Bearing Div., 2 pp. Price lists of "Tiger-Bronze" cored and solid bars and babbitt metals, all for bearing usage. (84)

Cored Forgings. National Cored Forgings Co., Inc., 8 pp, ill. Advantages and typical examples of cored forgings made of brass, bronze, copper and other nonferrous metals. (85)

Pressed Brass and Other Nonferrous Powder Parts. New Jersey Zinc Co., 32 pp, ill. A comprehensive detailed guide to the design, properties, production and applications of pressed brass and other nonferrous powder parts. (86)

Copper Tubing. Penn Brass & Copper Co., 6 pp, ill. Features of this company's seamless copper tubing. Includes tables of safe internal working pressures of various tubing sizes. (87)

Aluminum Mill Products. Reynolds Metals Co., 12 pp, ill, No. G1-8.5-852. Outlines increasing advantages of wrought aluminum alloys, lists Reynolds aluminum mill products, and details various product forms, finishes, alloys, tempers and sizes available. (88)

Cold-Rolled Brass Strip and Sheet. Scovill Mfg. Co., 24 pp, ill. Pictorially describes the facilities of Scovill's new continuous strip mill for producing cold-rolled brass strip and sheet. (89)

Brass and Bronze Products. Titan Metal Mfg. Co., 28 pp, ill. "Behind the Scenes" presents pictorial tour through various departments of Titan and briefly shows equipment for the manufacture of brass and bronze products to meet individual specifications. (90)

Nonferrous Castings. The Wellman Bronze and Aluminum Co., 16 pp, ill, No. 50. Characteristics, typical uses and specifications of Well-Cast magnesium, aluminum and copper-base alloys. (91)

Self-Lubricating Bearing. Wel-Met Co., 3 pp, No. 104. Lists 133 MPS standard self-lubricating bearing sizes, and gives inside and outside diameter and length dimensions. (92)

Light Metal Shapes. R. D. Werner Co., 4 pp, ill. Explains relative merits of cold roll forming and extruding light metal shapes. Shows company's facilities for both types of fabrication. (93)

Centrifugal Castings. Wisconsin Centrifugal Foundry Inc., 4 pp, ill. Techincal data on nonferrous machined products centrifugally cast and centrifuged for aircraft, diesel engine, railroad maintenance, machine tools, earthmoving machinery. (94)

Die Castings. Yoder Die Casting Inc., 4 pp, ill. Folder describes Yoder's complete die casting service and gives four ways in which die castings lower production costs. (95)

Nonmetallic Materials • Parts • Forms

Molded Plastics, Hard Rubber. American Hard Rubber Co., 80 pp, ill. Handbook of properties, tolerances and weights; design techniques, machining and finishing methods for this firm's hard rubbers and plastics. (96)

Felt Vibration Mounts. American Felt Co., 16 pp, ill. Description, uses, selection data and costs of Vibra-Mount felt mounts, said to cut transmitted vibration 85% (97)

Ceramics for the Foundry. American Lava Corp., 4 pp, ill, No. 522. Features sizes of Alsimag strainer cores and cut-off cores, and illustrates some of the principal uses of this firms' ceramics materials. (98)

Rigid Polyvinyl Chloride. American Lucoflex, Inc., 16 pp. Complete technical data on Lucoflex, a nonflammable, unplasticized polyvinyl chloride plastic, having outstanding thermal, chemical and physical properties. (99)

Custom Extrusions in Thermoplastics. Anchor Plastics Co., 4 pp, ill. Discusses forms and shapes of extruded plastics and gives a general summary as to how thermoplastics can be used by industry. Properties chart included. (100)

Rubber Parts. Automotive Rubber Co., Inc. Series of bulletins show use of rubber for insulation or corrosion prevention in industrial equipment. (101)

Plastic Molding Material. Bolta Products Sales, Inc., 4 pp, ill. Gives characteristics and advantages of Boltaron plastic molding material designed for low cost molding. (102)

Compounded Elastomers. Chicago Rawhide Mfg. Co., 32 pp, ill. Characteristics, properties and engineering applications of Sirvene compounded elastomers. (103)

Plastics. Ciba Co., Inc., Plastics Div. 625 Greenwich St., New York 14. Complete technical data on the physical properties and recommended procedures for the successful use of Araldite Resins for individual fabricating needs. Write direct to Ciba on company letterhead.

Coated Fabrics. The Connecticut Hard Rub-

MANUFACTURERS' LITERATURE

ber Co. Uses, chemical, electrical and mechanical properties, and availability of heat resistant silicone rubber coated glass fabrics. (104)

Vulcanized Fibre, Molded and Laminated Plastics. Continental-Diamond Fibre Co., 12 pp, ill. Technical data on a complete line of vulcanized fibre, molded and laminated plastics produced by this company. (105)

Molded and Extruded Rubber. Continental Rubber Works, 8 pp, No. 100. Gives dimensions of molded and extruded rubber with cross sectional illustration. Also condensed SAE and ASTM specification chart. (106)

Rubber Parts. Davidson Rubber Co., 4 pp, ill. Detailed description and specification of this company's sponge rubber and examples of some of the custom-made products produced. (107)

Silicones. Dow Corning Corp., 32 pp, ill. Indexed booklet attractively presents detailed information on a complete line of silicone products produced by this company. (108)

Glass Products. Dunbar Glass Corp., 4 pp, ill. Descriptions of this firm's various industrial glasses. Explains advantages of glass to the designer and gives physical properties. (109)

Plastics. E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., 12 pp, ill, No. A-3940. Introduces the various plastics produced by du Pont, and lists forms available properties, working techniques and principal uses. (110)

Phenolic Molding Compounds and Resins. Durez Plastics & Chemicals Inc., 4 pp, ill. Includes types, properties and uses of a variety of Durez phenolic molding compounds in industrial resins and coating resins. (111)

Vinyl Resins. Firestone Plastics Co., Chemicals Sales Div., 17 pp. Description and physical properties of Exon vinyl resins. Also, test procedures to determine volatile matter, relative viscosity and heat stabiliy. (112)

Laminated Thermosetting Plastic. Formica Co., 16 pp, ill, No. 314. Includes technical data on Formica, a laminated thermosetting plastic for electrical, chemical and mechanical applications. (113)

Setting Compound. Furane Plastics Inc., 1 p, No. A-2-52. Data on Furane Resin X-2, in conjunction with activated silica, which forms a remarkably fast setting compound. (114)

Neoprene Cold Bond System. Gates Engineering Co., 4 pp, ill, No. N-4. Advantages and properties of the Gaco cold bond system for bonding cured Neoprene sheet to metal, wood and concrete. (115)

Plastic-Faced Plywood. Georgia-Pacific Plywood & Lumber Co., 4 pp, ill. Applications, properties and description of CPX high grade exterior plywood coated with plastics. (116)

Plastics. General Electric Co., Plastics Div., 16 pp, ill., No. 16/13. Characteristics, uses and properties of this company's various molded and laminated plastics. (117)

Silicone Rubber. General Electric Co., Chemical Div. "The Silicone Story" suggests new design possibilities of G-E silicones (resin SR-98). (118)

Plastics. General Industries Co., 16 pp, ill. Profusely illustrates the facilities of this company for producing a wide variety of low-cost custom-molded plastics. (119)

Rubber Cushioned Parts. General Tire & Rubber Co., 12 pp, ill. Describes General Silentbloc method of mounting coupling or isolating moving machinery on rubber. Shows standard parts and specifications. (120)

Fiberglas Laminate. The Glastic Corp., 7 pp, ill. Describes Glastic's grade MM fiberglas-reinforced polyester laminates and gives mechanical, electrical and chemical properties. (121)

Rubber Putty. B. F. Goodrich Co., 2 pp, ill, No. 9765. Uses, advantages and directions for use of Plastikon rubber putty, said to be permanent, water-tight, air-tight and nonhardening. (122)

Vinyl Resin. Goodyear Tire and Rubber Co., Chemical Div. TechnicGuide Nos. PVR-100-2 and 100-3 gives characteristics, physical properties, uses and advantages of dispersion resins in organosols and plastisols. (123)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pp, ill, No. 108. Describes Graphalloy grades for bushings and electrical uses. Bearing design data included. (124)

Molded Packings. Greene, Tweed & Co., 4 pp, ill, No. MP-22. Features Palmetto Pyramid molded packings designed for more efficient, longer-lived hydraulic and pneumatic sealing. (125)

Thermosetting Resins. Houghton Laboratories, Inc. Describes Hysol 6000 Series of plastics said to combine exceptional electrical properties with superior mechanical properties. (126)

Molded Plywood. Keller Products, Inc., 12 pp, ill. Discusses standard and constantly used die shapes for molding plywood as an aid to designers of molded plywood shapes. (127)

Self-Lubricating Bearings. Metallized Carbon Corp., 4 pp, ill. Includes typical mechanical and electrical applications of self-lubricating bearings made of metallized carbon-graphite. (128)

Carbon Products. Morganite, Inc., 8 pp, ill, No. lf. Specifications of various carbon bearings and bushings. Also, properties of six series of Morganite carbon products. (129)

Carbon and Graphite Products. National Carbon Co., 20 pp, ill, No. S-5005. Chemical, metallurgical, mechanical and electrical applications of National carbon and graphite and Karbate impervious carbon and graphite products. (130)

Laminated Plastic. National Vulcanized Fibre Co., 16 pp, ill, No. 1b/12. Physical, electrical, mechanical and chemical properties of Phenolite laminated plastic sheet, rods, tubing and special shapes. Properties of National Vulcanized Fibre also listed. (131)

Molding and Extrusion Compounds. Naugatuck Chemical Div., 3 pp. Folder of technical data sheets on properties, features, uses and handling methods of Kralastics, plastics and elastomeric combinations. (132)

Calcium Silicates. Owens-Illinois Glass Co., Kaylo Div., 24 pp, ill. "The Story of Kaylo" gives complete data on Kaylo calcium silicate products and their various uses. (133)

Carbon Graphite. Pure Carbon Co., Inc., 32 pp, ill, No. 52. Complete technical data on description, properties, applications and specifications of Purebon carbon graphite. (134)

Extruded and Molded Rubber Parts. Republic Rubber Div., 12 pp, ill. Describes facilities for custom manufacture of molded and extruded rubber products. Describes various products. (135)

Flexible Hose. Resistoflex Corp., 4 pp, ill. Includes chemical and physical properties and typical applications of Resistoflex flexible hose. (136)

Plastics. The Richardson Co., 2783 Lake St., Melrose Park, Ill., 24 pp, ill, No. 836. *"Facts about Plastics"* gives basic introduction to plastics, their production and uses in industrial and consumer products. Request direct from Richardson on company letterhead.

Plastics Parts. Rogers Corp., 36 pp. Features of Fiberlog laminated and impact phenolics, vulcanized fibres and paperboards indicating possible applications. (137)

Acrylic Plastic Molding Powder. Rohm & Haas Co., 12 pp, ill, No. PL 86a. Designs, properties and applications of a variety of Plexiglas acrylic plastic molding powders. (138)

Sponge Polyvinyl Chloride Plastic. Sponge Rubber Products Co., 3 pp, ill. Outstanding features, physical properties, chemical resistance of unicellular polyvinyl chloride plastic. (139)

Electronic Components. Stackpole Carbon Co., 42 pp, ill. No. RC-8. Catalog shows complete line of this company's electronic components. Includes helpful engineering data. (140)

Ceramic Parts. Star Porcelain Co., 24 pp, ill, No. 1251. Brochure gives descriptions, design suggestions and specifications of ceramic bodies used in the manufacture of electrical and electronic equipment. (141)

Liquid Polymer. Thiokol Corp., 4 pp, ill. Includes physical properties and typical applications of Thiokol Liquid Polymer LP-2, a viscous liquid that converts to a tough solvent resistant rubber at room temperature. (142)

Honeycomb for Lightweight Structures. U. S. Plywood Corp., 24 pp, ill. Complete data on honeycomb "sandwich construction", a combination of honeycomb core, adhesive and two relatively thin, dense, high strength faces or skins. (143)

Thermoplastic. Van Dorn Iron Works Co., 16 pp. Technical data on properties, available forms, fabrication and applications of Lucoflex, a rigid polyvinyl chloride. (144)

Finishes • Cleaning and Finishing

Cleaning and Finishing Media. Almco Div., Queen Stove Works, Inc., 10 pp, ill. Features and applications of Supersheen abrasive chips and compounds for barrel finishing and cleaning. Also data on finishing machines. (145)

Phospate Coating Chemicals and Processes. American Chemical Paint Co., 12 pp, ill, No. P-100-46. Includes typical applications and specifications of a variety of ACP phosphate coating chemicals and processes. (146)

Hot Dip Galvanizing. American Hot Dip

Galvanizers Assn., Inc., 8 pp, ill. Discusses hot dip galvanizing, the problems encountered by galvanizers, and its capabilities. (147)

Metal Sealer. American Metaseal Corp., 4 pp, ill. Advantages, applications and properties of Metaseal 19V5, which invisibly stops leakage, pressure bonds similar and dissimilar materials, increases diaelectric resistivity, etc. (148)

Grinding and Polishing Stainless Steel. American Nickeloid Co. Gives facilities for custom grinding and polishing stainless steel, and describes firm's capacities for handling sheets up to 60 in. by 144 in. (149)

Airblast Cabinets. American Wheelabrator & Equipment Corp., ill, No. 31-A. Shows a complete line of suction-type and pressure-type airblast cabinets in various sizes to serve a range of applications. (150)

Burnishing Compound. Apothecaries Hall Co., 1 p, No. B-4. Discusses AHCO Burnishing Compound B, a free-flowing, dry, mildly alkaline powder developed especially for burnishing aluminum parts to a smooth, high lustre. (151)

Black Mineral Shot. Baldwin-Hill Co., 4 pp, ill. Lists the many advantages of using specially processed B-H black mineral shot for blast cleaning applications. (152)

Cloth Belts. Behr-Manning Corp., 8 pp, ill, No. 726E. Folder features price list of complete line of Metalite cloth belts for polishing and grinding. (153)

Polishing Wheel. The Carborundum Co., 4 pp, ill. Illustrates features and operation of Cone-Loc drum sanders, said to reduce operational cost of many applications. (154)

Plating Tanks. The Chemical Corp., 4 pp, ill. Data sheets on chemical resistance of resin-bonded Fiberglas plating tanks, their specifications and advantages. (155)

Wet-Blasting Units. The Cro-Plate Co., 4 pp, ill. Describes new line of wet-blasting units for high production deburring, descaling, stock removal and general finishing. (156)

Metal Parts Washers. Detrex Corp., 16 pp, ill, No. 174. Profusely illustrates a complete line of Detrex metal cleaning machines, metal cleaning chemicals and processing equipment. (157)

Cleaning and Phosphatizing Material. Diversey Corp. Discussess Divobond, mildly acid compound which cleans and phosphatizes iron and steel in a single spray operation. (158)

Magnesium Finishing. Dow Chemical Co., Magnesium Dept., 128 pp. A revised edition of the manual on finishing systems for magnesium products. (159)

Metal Finishing. Enthone, Inc., 4 pp, No. 13021. Operating instructions for the Ebonol "C" process of blackening and coloring copper and copper alloys. (160)

Protective Coating. Flexrock Co., Protective Coatings Div., 4 pp, ill. Complete data on Flexcoat 311, a vinyl-acrylic base industrial coating that stops corrosion and contamination. (161)

Power Driven Brushes. The Fuller Brush Co., 32 pp, ill. Describes Fullergript brushes, their application to such processes as scrubbing steel sheet and tampico brushing. (162)

New Equipment for Coating. The Gyromat Corp., 4 pp, ill. Describes Norris Gyromat, centrifugal spraying machine said to apply standard industrial coatings and finishes faster, more economically. (163)

Washing and Drying Machines. Industrial Washing Machine Corp., 10 pp, ill. Profusely illustrates a complete line of industrial washing and drying machines for washing, rinsing, slushing and drying operations. (164)

Flame-Plating. Linde Air Products Co., 12 pp, ill, No. F-8065. Features properties and applications of flame-plating, a method of applying thin metallic coatings, such as tungsten carbide, on metal parts. (165)

Protective Coating. Maas & Waldstein Co., No. 117. Technical data on Water Dip # 33, protective coating for plated metal surfaces said to afford good oxidation protection. (166)

Plastic Rubber Coatings. Magic Chemical Co. Revised edition contains complete data on Magic-Vulc anti-abrasion and anti-corrosion plastic rubber coatings. (167)

Zinc Dust Paints. New Jersey Zinc Co., 36 pp, ill. Characteristics and uses of zinc dust paints, most adherent paints for galvanized iron and steel zinc. (168)

Metal Cleaner. Niagara Alkali Co. Pamphlet gives properties of Nialk Trichlorethylene, high quality metal-cleaning and degreasing agent. (169)

Electrocleaning Zinc-Base Die Castings. Oakite Products, Inc., 6 pp, No. F-8654. Discusses Oakite Composition No. 95, a new anodic conditioner for zinc-base die castings. (170)

Power Brush Finishing. Osborn Mfg. Co., 12 pp, ill, No. L-272. A comprehensive article covering the important factors in the selection and application of brushes for specific finishes. (171)

Drum Cleaning. The Pangborn Corp., 6 pp, ill, No. 220. Brochure explains Rotoblast technique in cleaning drums and covers. Also includes safeguards, specifications and diagrams on operation. (172)

Paint Spraying Equipment. Scientific Electric, 4 pp, ill. Presents the "Ionic" gun and other ionic high potential paint spraying equipment. (173)

Inorganic Coating. Turco Products, Inc., 4 pp, No. A-106. Discusses a complete line of Turcoating materials, designed to fill every conceivable phosphating requirement and to meet applicable Government specifications. (174)

Protective Coating. United Chromium, Inc., 2 pp, ill, No. RC-2. Properties and uses of Unichrome Coating 218X, a vinyl plastisol material for coating plating and conveyor racks, plating barrels, agitators, etc. (175)

Corrosion Resistant Linings. U. S. Stoneware, Process Equipment Div., 12 pp, ill, No. TL-526. Technical data and typical applications of Tygon corrosion resistant linings. (176)

Hard Chromium Plating Unit. Ward Leonard Electric Co., 4 pp, ill. Features of Model A-20 Chromaster industrial hard chromium plating unit, description of process and Chromasol solution. (177)

Sealing Process for Castings. Western Sealant, Inc., 7 pp, ill. Discusses process for eliminating porosity from metal castings and fibreglas laminates without visible effects. (178)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 251

Heat Treating • Heating

Induction Heating Furnaces. Ajax Electrothermic Corp., 12 pp, ill, No. 13-A. Includes advantages and applications of a complete line of Ajax-Northrup high frequency furnaces for forging, upsetting, spinning, annealing, hardening, etc. (179)

Seamless Aluminum Tubing. American Brass Co., 1 p. ill. Describes and illustrates small diameter, precision finished seamless tubing produced by the French Small Tube Branch of American Brass. (180)

Salt Baths. American Cyanamid Co., 16 pp, ill, No. 544-4. Features case histories of several companies who employed Cyanamid's heat treating compounds with Cyanamid's technical service. A list of the compounds and their properties are included. (181)

Case-Hardening Process. American Gas Furnace Co. Principles of "Ni-Carb" case-hardening, its advantages, and descriptions of AGF furnaces for the process. (182)

Low Temperature Units. Bowser Technical Refrigeration Div., Bowser, Inc., 2 pp, ill, No. T-1150-2A. Describes new series of units with temperatures down to -150 F for the cold treatment of metals. (183)

Box Muffle Furnaces. Burrell Corp., 4 pp, ill, No. 315. Includes specifications and prices of five "Unit Package" box muffle furnaces for low and high temperature testing operations. (184)

Furnace Heating Elements. Carborundum Co., Globar Div. Complete data on Globar silicon carbide heating elements, said to be efficient, safe and easy to repair. (185)

Electric Ovens and Furnaces. Cooley Electric Mfg. Corp., ill. Describes a complete line of electric ovens and furnaces produced by this company. Includes specifications. (186)

Roller Hearth Furnaces. Drever Co., 8 pp, ill, No. B-90. Profusely illustrates a variety of oil, gas or electrically heated, direct fired or radiant tube roller-hearth furnaces. Includes specifications. (187)

Electric Sintering Furnaces. The Electric Furnace Co., 4 pp, ill. Descriptions and uses of nine EF sintering furnaces. (188)

Electric Furnaces. Harper Electric Furnace Corp., 4 pp, ill, No. 252. Presents features and specifications of furnaces for all types of research and small scale production. (189)

Heat Treating Furnaces. C. I. Hayes, Inc., 4 pp, ill. Profusely illustrates a variety of furnaces that offer insured heat treating results. (190)

Pit Type Convection Furnace. Hevi Duty Electric Co., 6 pp, ill, No. IND-451. Describes use, construction and specifications of Hevi Duty pit type furnaces. Installation photographs show some important industrial applications. (191)

High Frequency Heating Unit. Lepel High Frequency Laboratories, Inc., No. MM-11. Shows low cost, high frequency unit for

MANUFACTURERS' LITERATURE

such jobs as brazing, soldering and annealing. (192)

Heat Treating Furnaces. Lindberg Engineering Co., 8 pp, ill, No. 131. Operation, design features, applications and specifications of a complete line of gas fired and electric super cyclone furnaces. (193)

Tubular Furnaces. Marshall Products Co., 4 pp, ill. Discusses both the creep test and tensile test models of Marshall tubular furnaces as well as control panels and radial brackets. Includes specifications. (194)

Electric Furnaces. Pereny Equipment Co., 3 pp, ill, No. 4A. Booklet tells advantages and illustrates typical group of this company's furnaces and kilns and their uses. (195)

Heat Treating Equipment. Sunbeam Corp., Sunbeam Stewart Industrial Furnace Div., 4 pp, ill. Vol. 10, No. 6. "Metal Minutes" shows various applications of this company's equipment in user's plants. (196)

Electric Radiant Panels. Edwin L. Wiegand & Co., 6 pp, ill, No. CS605. Folder includes a variety of applications of Chromalox electric radiant panels—compact, "packaged" for infra-red generators. (197)

Welding • Joining

Rubber-to-Metal Bonding. Acushnet Process Co., 8 pp, ill, No. 51-A. Supplement A to the Acushnet rubber data handbook gives more detailed information concerning the rubber-to-metal adhesion process. (198)

Inert-Gas-Shielded Metal-Arc Process. Air Reduction Co., Inc., 12 pp, ill, No. ADC-717-B. Describes equipment and supplies used in Aircomatic welding, Airco's inert-gas-shielded metal-arc process. Specifications included. (199)

Arc Welding Electrodes. Alloy Rods Co., 4 pp, ill, No. AR52-2218. Complete data on Nickel-Arc 60 electrodes for machinable welds on cast iron of all types. (200)

Silver Brazing. American Platinum Works, 48 pp, ill. Reference manual on silver brazing discusses low temperature brazing, brazing alloys, design considerations and other topics. (201)

Stainless Fasteners Specifications. Anti-Corrosive Metal Products Co., Inc., slide indicator. Identifies the type of fastener specified by each A-N number pertaining to the stainless fasteners. Refers user to this company's catalog for more data. (202)

Low Hydrogen Welding Electrodes. Arcos Corp., No. 45118. Folder contains questions and answers on low hydrogen electrodes, selector chart for welding high strength steels and specification data on the new Tensilend electrodes. (203)

Welding Cost Calculator. Champion Rivet Co., slide indicator. Shows the costs for welding materials using various types of fillets and joints and estimate the various factors effecting the costs. (204)

Vinyl Adhesives. Chemical Development Corp., 1 p, ill. Includes prices of various cements for bonding vinyl plastics and other substances to themselves and to metal, glass, cloth and many other surfaces. (205)

Rosin Core Solder. Division Lead Co., 4 pp. Features Divco's X-25 Rosin Core Solder, which provides flux activity at a temperature even before the solder is completely molten. (206)

Pin-Type Self Locking Fastener. Elastic Stop Nut Corp., 15 pp, ill, No. 800. Case histories and engineering data for the "Roll-pin" self-locking fastener. (207)

Solder Alloys. Federated Metals Div., 36 pp, ill. Properties of fusible alloys, principles and thermal effects of soldering and applications, descriptions and specifications of this company's solders. (208)

Solder Paint. Fluxolder Products Co., 22 pp, ill. Advantages, operations and uses of Fluxolder solder paint. (209)

Welding Rod Coating Materials. Foote Mineral Co. Chemical specifications and general description of alloying materials, binders and slipping agents, arc stabilizers and fluxes. (210)

Wing Nuts. Gries Reproducer Corp. Data on zinc alloy wing nuts, said to be strong, rust-proof, low cost, available in all commercial finishes and thread sizes. (211)

Brazing. Handy & Harman, ill, No. 54. "Brazing News" describes applications and developments of Easy-Flo and Sil-Fos low temperature silver brazing alloys. (212)

Gas Drive Arc Welders. Hobart Brothers Co., 8 pp, ill, No. J-4806. Electrical and mechanical specifications of a complete line of gasoline engine-driven arc welders. (213)

Aluminum Fasteners. The Jacques Co., 8 pp, ill, No. 50A. Price list and specifications of this company's line of aluminum fasteners. (214)

Submerged Arc Welding. Linde Air Products Co., 12 pp, ill, No. F-7945. Results of bend test of weld beads deposited without preheating or postheating. Also contains diagrams showing the time-temperature relationship for complete isothermal change in 24 grades of SAE steel. (215)

Silver Alloy Preforms. Lucas-Milhaupt Engineering Co., 4 pp, ill, No. 52-1-A. Comprehensive information on the use of silver alloy preforms for better brazing performance. (216)

Electrodes and Holders. P. R. Mallory & Co., Inc., Welding Div., 2 pp, ill, No. 8-11. Advantages, design and application of 8-deg (4 deg per side) 5/8-in. dia spot welding electrodes and holders. (217)

Fasteners. Milford Rivet & Machine Co., 12 pp, ill, No. MM 52. Detailed information on an integrated service of fastener research, design, engineering and production collaboration. (218)

Fastener. New Process Screw Co. Bulletin describes Twin-fast screws for rapid fastening of wood to metals, plastics or other woods. (219)

Gold and Platinum Solders. The J. M. Ney Co., 1 p. Data sheet gives melting ranges and colors of this company's gold and platinum solders for electronic tube applications. (220)

Snap Nut Fasteners. Prestole Corp., 2 pp, ill, No. 8000-A. Features specifications of three types of Prestole self-locking fastening units, available in all standard metal finishes. (221)

Bench Welder. Raytheon Mfg. Co., 2 pp, ill. Features, specifications and advantages of Raytheon bench welder, claimed to enable precise welding by several methods. (222)

Titanium Fasteners. Reed & Prince Mfg. Co., 4 pp, ill. Includes properties and characteristics of metallic titanium screws, nuts and rivets that are strong as steel but 40% lighter. (223)

Lock Screw Fasteners. Russell, Burdsall and Ward Bolt & Nut Co., 3 pp, ill. Features, advantages and dimensions of this company's spin-lock screws. (224)

Set Screws. Set Screw & Mfg. Co., 20 pp, ill, No. 16. List prices and dimensional information on a complete line of Setko and Zip-Grip set screws. (225)

Fastening Specialties. Southco Div., South Chester Corp., 22 pp, ill, No. B-2. Information on industrial fasteners for metal-to-metal and metal-to-wood applications, including installation procedure and dimensional data. (226)

Self-Locking Nuts. Standard Pressed Steel Co., Flexloc Locknut Div., 27 pp, ill, No. 619-B. Technical data on a complete line of Flexloc self-locking nuts in both thin and regular design. (227)

Welding Procedure. Stoody Co. Folder describes welding procedure for repairing metal parts, such as top carrier rolls for tractor treads. (228)

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Moly-Sulfide Lubricant. Climax Molybdenum Co., 40 pp. Detailed tables of applications of moly-sulfide lubricant in the manufacturing plant, the job shop and in the field, indicating form used and results of application. (229)

Compacting Presses. Baldwin-Lima-Hamilton Corp., 4 pp, ill, No. 3100. Features characteristics and specifications of Baldwin-Defiance compacting presses. (230)

Government Specification Products. E. F. Houghton & Co., 7 pp. Handy reference listing of Houghton production meeting government specifications. Listing includes specification numbers, description and name of approved Houghton product. (231)

Machining Hard Metals. The Method X Co., 4 pp, ill, No. SA1018. Features, operation, tolerances and applications of new machine said to facilitate fabrication of sintered carbides, S-816, etc. (232)

Grinding Titanium. Norton Co., 24 pp, No. 524. Detailed technical data covering complete grinding recommendations for titanium. (233)

Sheet Metal Fabricator. Wales-Strippit Corp., 6 pp, ill, No. 10-A. Gives features and specifications of Hydra-New-Matic head and the "Quick Change" holder. (234)

Aluminum Extrusion Presses. Watson-Stillman, ill, No. 340-A. Describes this company's light metals extrusion presses of 500- to 5,000-ton capacities, their features and advantages. (235)

Magnetic Perforating Dies. S. B. Whistler & Sons Inc., ill. Complete descriptions and applications of this company's magnetic perforating dies. (236)

Inspection • Testing • Control

Radium Radiography. Atomic Energy of Canada Ltd., Commercial Products Div., P. O. Box 379, Ottawa, Canada, 71 pp, ill,

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price $2.00. Detailed theory, equipment and applications of radium radiography. Available directly from Atomic Energy of Canada.

Industrial Stereomicroscope. Bausch & Lomb Optical Co., 4 pp, ill, No. D-1029. Includes prices of various industrial stereomicroscopes and their accessories for speeding production and quality control operations. (237)

Films for Surface Analysis. The Brush Development Co., ill, No. 653. Applications of, and equipment for using Faxfilm for microscopically examining surfaces of various materials. (238)

Testing Machines. Buehler Ltd., 8 pp, ill. Shows Amsler testing machines for tension, compression, torsion, shear fatigue, bending and ductility tests on various materials. (239)

Wrattan Filters for Technical Use. Eastman Kodak Co., 78 pp, price 75¢. "Kodak Wrattan Filters for Scientific and Technical Use" lists over 100 filters having applications in black-and-white and color photography and discusses forms and types of filters, their standard uses and care. (240)

Thermocouples. Charles Engelhard, Inc., No. 330-D. Shows features of full line of this company's metal thermocouples. (241)

Metallurgical Laboratory Equipment. Harshaw Chemical Co., Harshaw Scientific Div., 12 pp, ill, No. D2637. Catalog describes and gives specifications of this company's available metallurgical laboratory equipment. (242)

Tensile Testing Unit. Instron Engineering Corp., 4 pp, ill. Specifications and applications of the Instron tensile testing instrument Model TT-B, a high precision electronic tensile testing unit. (243)

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Recorders and Indicators. Minneapolis-Honeywell Regulator Co., Brown Instrument Div., 44 pp, ill, No. 1520. Factual information on ElectroniK recorders and indicators for measuring temperature, pressure, flow, pH, etc. Includes specifications. (245)

Impact Testing Machines. National Forge & Ordnance Co., Testing Machine Div., 4 pp, ill, No. 523. Discusses a new low capacity impact tester for plastics, ceramics and light metals. Includes specifications. (246)

Temperature Controls. The Pyrometer Instrument Co., No. 150. Catalog shows Pyro Immersion Pyrometer, accurate instrument for nonferrous foundry temperature control. (247)

Impact Testing Machine. Riehle Testing Machines Div., American Machine & Metals Inc., 6 pp, ill, No. RM-8-52. Booklet gives operating features and specifications of the Riehle Model PL-2 impact testing machine. Also illustrates other Riehle testing machines. (248)

Tensile Testing Machines. Scott Testers Inc., 6 pp, ill, No. 50. Shows wide assortment of testing machines for testing tensile strength of materials such as rubber, paper wire and thread. (249)

X-Ray Gage. Sheffield Corp., 14 pp, ill, No. MY-52-3. Complete data on the "50" Series Measuray, a noncontact x-ray gage for continuous or intermittent measurement of strip or sheet stock while in motion or stationary. (250)

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Screw Machine Parts and Other Metal Forms. Worthington Corp., 7 pp, No. W-350-B5C. Describes valves, flanges, hose nipples, bars, welding electrodes and screw machine products available. (257)

General

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Vacuum Pump. Kinney Mfg. Co., Vo. V-51B. Complete details on Kinney vacuum pump for every vacuum requirement. (262)

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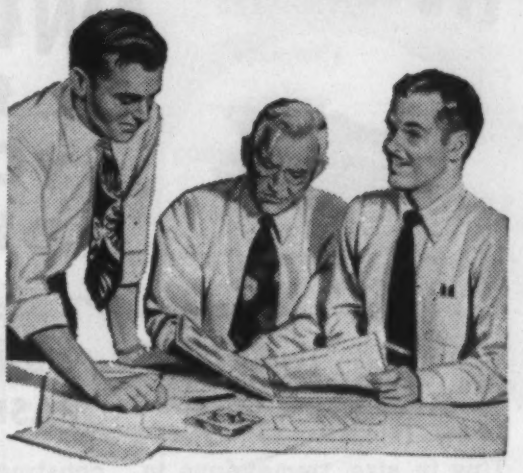

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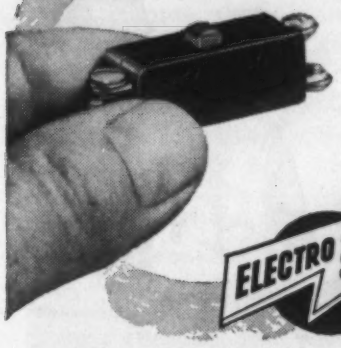

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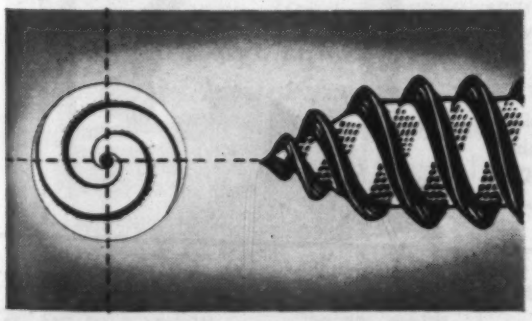

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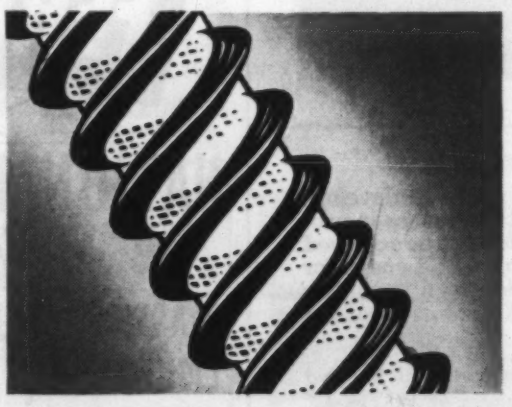

There are two major advantages in this greater thread pitch: (a) With a single turn of the driver, twice as much thread area enters the wood as with ordinary screws under the same performance. Driving time is thereby cut in half. (b) Since only half as many turns of the driver are required, the threads cut by the screw as it travels into the wood are subjected to only half as much friction and wear. The stripping torque is substantially increased. The threads themselves are specially designed and have hard, sharp, blade-like edges which cut deep, clean threads into the wood.

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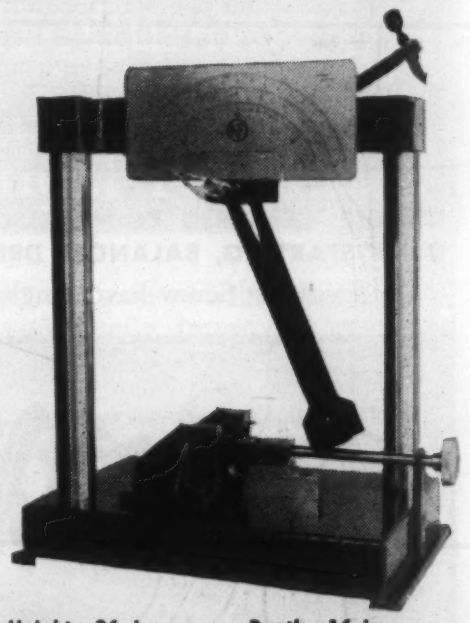

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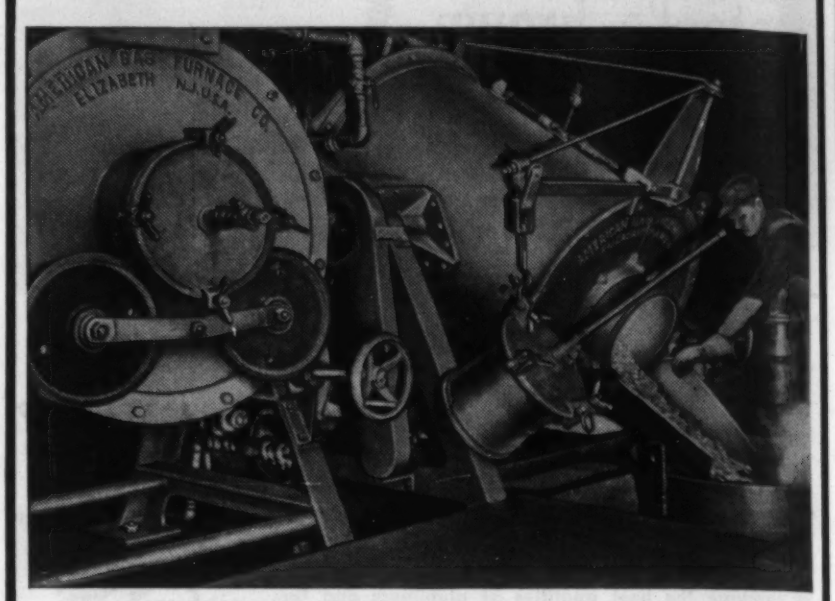

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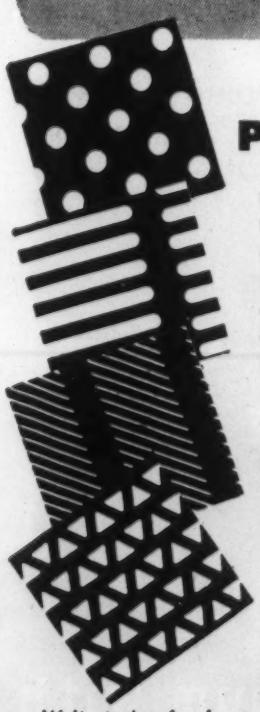

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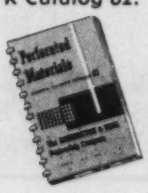

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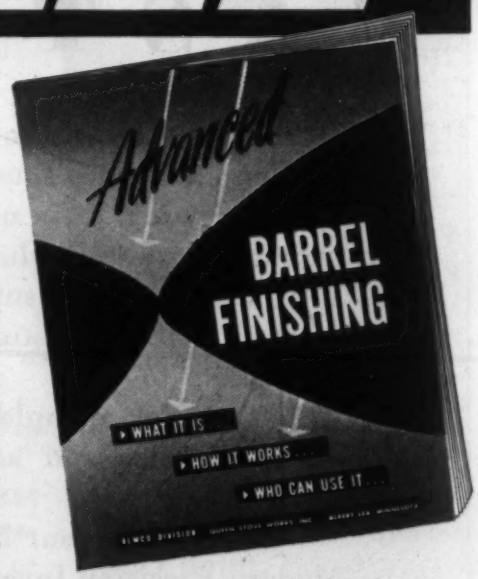

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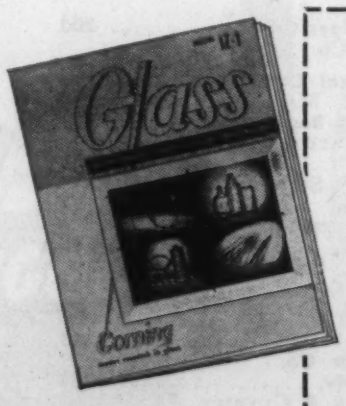

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Ajax Electric Co., Inc. 37
Agency—Harry P. Bridge Co.
Ajax Electric Furnace Corp. 220
Ajax Electrothermic Corp. 170
Agency—Robert D. Towne Advertising
Ajax Engineering Corp. 216
Agency—Eldridge, Inc.
Allied Chemical & Dye Corp. 186, 243
Allied Research Products, Inc. 174
Agency—Emery Advertising Corp.
Almco Div. 262
Agency—Weston-Barnet, Inc.
Aluminum Company of America 258, 261
Agency—Fuller & Smith & Ross, Inc.
American Agile Corp. 250
Agency—Herb W. Buerger Advertising
American Brake Shoe Co. 81, 144
American Brass Co. .....2nd Cover
Agency—Kenyon & Eckhardt, Inc.
American Chain & Cable Co., Inc., ... 178
American Chemical Paint Co. 152
Agency—May Advertising Co.
American Crucible Products Co. 228
Agency—Wendt Advertising Agency
American Cyanamid Co., Plastics Div. ..38, 39
Agency—Hazard Advertising Co.
American Felt Co. 169
Agency—St. Georges & Keyes, Inc.
American Gas Furnace Co. 262
Agency—Advent Associates, Inc.
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Agency—Robert D. Towne Advertising
American Photocopy Equipment Co. 250
Agency—Irving J. Rosenbloom Advertising Agency
American Platinum Works 19
Agency—Stuart Sande Advertising
American Silver Co., Inc. 262
American Sintered Alloys Div. 18
Agency—Ruthrauff & Ryan, Inc.
American Steel & Wire Co. 135, 136, 137, 138
American Welding & Mfg. Co. 47
Agency—Bayless-Kerr Co.
Ampco Metal, Inc. 30, 31
Agency—Hoffman & York, Inc.
Amplex Manufacturing Co. 215
Agency—Witte & Burden
Armstrong Cork Co., Industrial Div. 240
Agency—Batten, Barton, Durstine & Osborn, Inc.
Atlantic Casting & Engineering Corp. 190
Agency—Wehner Advertising Service

Bakelite Co. 71
Agency—J. M. Mathes, Inc.
Baldwin-Lima-Hamilton Corp. 60, 61
Agency—Ketchum, MacLeod & Grove, Inc.
Barber-Colman Co. 43
Bausch & Lomb Optical Co. 87
Agency—Ed Wolff & Associates
Bellevue Industrial Furnace Co. 218
Agency—Hyatt Eby
Belmont Smelting & Refining Works, Inc. .. 214
Agency—Raf Advertising, Inc.
Beryllium Corp. 74
Agency—Gray & Rogers
Bethlehem Steel Co. 45, 72, 177
Agency—Jones & Brakeley, Inc.
Biggs, Carl H., Co. 267
Agency—Lott Advertising Agency

Brainard Steel Div. 213
Agency—Griswold-Eshleman Co.
Bridgeport Brass Co. 33
Agency—Hazard Advertising Co.
Buehler, Ltd. 248
Agency—Kreicker & Meloan, Inc.
Bundy Tubing Co. 167
Agency—Brooke, Smith, French & Dorrance, Inc.
Carborundum Co. 16, 17
Agency—Comstock & Co.
Carborundum Co., Globar Div. 244
Agency—Comstock & Co.
Carlson, G. O., Inc. 194
Agency—Foltz-Wessinger, Inc.
Cerro de Pasco Corp. 82
Agency—Thoma & Gill
Chace, W. M., Co. 192
Agency—Fred P. Bingham Technical Advertising
Chase Brass & Copper Co. 41
Agency—Cunningham & Walsh, Inc.
Chemical Corp. 230
Agency—William B. Remington, Inc.
Chicago Steel Foundry Co. 246
Agency—Wamsley & Heer, Inc.
Chrysler Corp. 215
Ciba Co., Inc. 205
Agency—Briggs & Varley, Inc.
Cincinnati Milling Machine Co., Hydroform Div. 34, 35
Agency—Keelor & Stites Co.
Clark Bros. Bolt Co. 260
Agency—McNevin-Wilson-Dalldorf, Inc.
Climax Molybdenum Co. 226
Agency—Rowlinson-Broughton
Coated Coil Corp. 267
Agency—Harold Marshall Advertising Co.
Cohn, Sigmund, Mfg. Co., Inc. 222
Agency—William G. Seidenbaum Advertising Agency
Colorado Fuel & Iron Corp. 225
Agency—Doyle, Kitchen & McCormick, Inc.
Columbia-Geneva Steel Div. 135, 136, 137, 138
Continental-Diamond Fibre Co. 63
Agency—Charles Blum Advertising Corp.
Cooper Alloy Foundry Co. 64
Agency—Mahool Advertising. Inc.
Corning Glass Works 265
Agency—Charles L. Rumrill & Co., Inc.
Crucible Steel Co. of America 49, 163, 207, 237
Agency—G. M. Basford Co.
Cullen-Friestedt Co. 218
Agency—Ross Llewellyn, Inc.
Dollin Corp. 204
Agency—Thoma & Gill
Dow Chemical Co. 239
Agency—MacManus, John & Adams, Inc.
Dow Corning Corp. 142
Agency—Don Wagnitz Advertising Co.
Driver-Harris Co. 241
Agency—Lewin, Williams & Saylor, Inc.
du Pont, E. I., de Nemours & Co., Inc., Polychemicals Dept. .....3rd Cover
Agency—Batten, Barton, Durstine & Osborn, Inc.
Duraloy Co. 182
Agency—Sanger-Funnell, Inc.
Durez Plastics & Chemicals, Inc. 191
Agency—Comstock & Co.

Eastman Kodak Co. 189
Agency—J. Walter Thompson Co.
Electric Auto-Lite Co. 67
Agency—Ruthrauff & Ryan, Inc.
Electro-Alloys Div. 144
Agency—Fuller & Smith & Ross, Inc.
Electro-Snap Switch & Mfg. Co. 258
Agency—Glenn, Jordan, Stoetzel, Inc.
Engineered Precision Casting Co. 246
Agency—Advent Associates, Inc.
Enthone, Inc. 247
Agency—Hugh H. Graham & Associates, Inc.
Eutectic Welding Alloys Corp. 200
Agency—Kotula Co.

Fansteel Metallurgical Corp. 196
Agency—Symonds, MacKenzie & Co.
Federal Telephone & Radio Corp. 223
Agency—J. M. Mathes, Inc.
Ferro Corp. 260
Agency—Fuller & Smith & Ross, Inc.
Firestone Plastics Co. 22, 23
Agency—Grey Advertising Agency, Inc.
Firth Sterling, Inc. 195
Agency—James A. Stewart Co.
Fluxolder Products Co. 248
Agency—Dudgeon, Taylor & Bruske, Inc.

Gamble Brothers 198
Agency—Mullican Co.
General Chemical Div. 243
Agency—Atherton & Currier, Inc.
General Electric Co., Apparatus Dept. 58, 245
Agency—G. M. Basford Co.
Geuder, Paeschke & Frey Co. 55
Agency—Cramer-Krasselt Co.

Goodrich, B. F., Chemical Co. 7
Agency—Griswold-Eshleman Co.
Graphite Metallizing Corp. 224
Agency—Kotula Co.
Gray Iron Founders' Society, Inc. 193
Agency—Fuller & Smith & Ross, Inc.
Gray-Syracuse, Inc. 232
Great Lakes Steel Corp. 149
Agency—Campbell-Ewald Co.

H. & H. Tube & Mfg. Co. 173
Agency—Henry Koltys Co.
Handy & Harman 203
Agency—Peterson & Kempner, Inc.
Hannifin Corp. 80
Agency—Buchen Co.
Harper Electric Furnace Corp. 238
Agency—Horace A. Laney Advertising
Harrington & King Perforating Co. 262
Agency—Merchandising Advertisers, Inc.
Hassall, John, Inc. 222
Agency—Anderson & Cairns, Inc.
Haynes Stellite Div. 197
Agency—J. M. Mathes, Inc.
Heli-Coil Corp. 212
Agency—O. S. Tyson & Co., Inc.
Hercules Powder Co. 28, 29
Agency—Fuller & Smith & Ross, Inc.
Holliday, W. J., & Co., Inc. 172
Agency—Tri-State Advertising Co., Inc.
Hunt-Spiller Mfg. Corp. 235
Agency—Charles M. Gray & Associates

Inland Steel Co. 2
Agency—Weiss & Geller, Inc.
Instrument Specialties Co., Inc. 226
Agency—Edwards Advertising
International Nickel Co., Inc. 5, 79
Agency—Marschalk and Pratt Co.

Johns-Manville Corp. 83
Agency—J. Walter Thompson Co.
Johnson Bronze Co. 175
Agency—Wearstler Advertising, Inc.

Kemp, C. M., Mfg. Co. 176
Agency—Vansant, Dugdale & Co.
Kester Solder Co. 216
Agency—Paul J. Steffen Advertising
Kinney Mfg. Co. 217
Agency—Hammond-Goff Co.
Koppers Co., Inc. 233
Agency—Batten, Barton, Durstine & Osborn, Inc.

La Salle Steel Corp. 187
Agency—Fensholt Co.
Lebanon Steel Foundry 232
Agency—Foltz-Wessinger, Inc.
Lenape Hydraulic Pressing & Forging Co. .. 260
Agency—Renner Advertisers
Lindberg Engineering Co. 20, 21
Agency—Shrout Associates
Linde Air Products Co. 86
Agency—J. M. Mathes, Inc.

Madison-Kipp Corp. 62
Agency—Buchen Co.
Magnaflux Corp. 209
Agency—Glenn, Jordan, Stoetzel, Inc.
Meehanite Metal Corp. 151
Agency—Herington Advertising, Inc.
Metal Hydrides, Inc. 202
Agency—Tippett, Jackson & Nolan, Inc.
Mica Insulator Co. 165
Agency—Hazard Advertising Co.
Michigan Powdered Metal Products Co., Inc. 154
Agency—Charles M. Gray & Associates
Michigan Steel Casting Co. 78
Agency—L. Charles Lussier, Inc.
Micrometrical Manufacturing Co. 210
Agency—Charles M. Gray & Associates
Midland Industrial Finishes Co. 206
Agency—Western Advertising Agency
Minneapolis Honeywell Regulator Co., Industrial Div. 26, 27
Agency—Aitkin-Kynett Co.
Minnesota Mining & Mfg. Co. 53
Agency—MacManus, John & Adams, Inc.
Mitchell-Bradford Chemical Co. 168
Agency—Langler Advertising Agency Inc.
Monarch Aluminum Manufacturing Co. .. 164
Agency—Lang, Fisher & Stashower, Inc.
Monsanto Chemical Company, Plastic Div. 183
Agency—Gardner Advertising Co.
Mt. Vernon-Woodberry Mills 159
Agency—J. B. Rundle, Inc.
Murray, A. B., Co., Inc. 204
Agency—Fred M. Reast
Murray-Way Corp. 242
Agency—F. B. Hubert Advertising Counsel

National Bearing Div. 81
Agency—Fuller & Smith & Ross, Inc.
National Carbon Co. 231
Agency—William Esty Co., Inc.
National Forge & Ordnance Co. 260
Agency—Moss-Chase Co.
National Lead Co. 46
National Steel Corp. 149
National Tube Div. 135, 136, 137, 138

Newage International, Inc. 228
Agency—Julian L. Marwell Advertising
New Jersey Zinc Co. 12
New Process Screw Corp. 259
Agency—James Thomas Chirurg Co.
Niagara Alkali Co. 36
Agency—Hazard Advertising Co.
Nitrogen Div. 186
Agency—Albert Sidney Noble
Northwest Chemical Co., Inc. 185
Agency—Hyatt Eby
Norton Co. 76
Agency—James Thomas Chirurg Co.

Oakite Products, Inc. 258
Agency—Rickard & Co., Inc.
Ohio Crankshaft Co. 211
Agency—Carr-Liggett Advertising, Inc.
Ohio Rubber Co. 82
Agency—G. M. Basford Co.
Ohio Seamless Tube Co. 85
Agency—Howard Swink Advertising Agency, Inc.
Olsen, Tinius, Testing Machine Co. 77
Agency—Renner Advertisers
O'Neil-Irwin Manufacturing Co. 224
Agency—Foulke Agency, Inc.
Oregon Lumber Co. 48
Agency—Pacific National Advertising Agency
Osborn Manufacturing Co. 179
Agency—Griswold-Eshleman Co.

Palnut Co. 82
Agency—Thoma & Gill
Penn Engineering & Mfg. Corp. 230
Agency—Michener Co.
Pittsburgh Steel Co. 73
Agency—Bond & Starr, Inc.
Powdered Metal Products Corp. 184
Agency—Waldie & Briggs, Inc.
Precision Metalsmith, Inc. 180
Agency—Fuller & Smith & Ross, Inc.
Pressed Steel Tank Co. 150
Agency—Buchnen Co.
Products Research Co. 234
Agency—Van der Boom, Hunt, McNaughton, Inc.

Queen Stove Works, Inc. 262

Radium Chemical Co., Inc. 234
Reichhold Chemicals, Inc. 140
Agency—McManus, John & Adams, Inc.
Reinhold Publishing Corp. 56, 57
Republic Steel Corp. 52
Agency—Meldrum & Fewsmith, Inc.
Republic Steel Corp., Steel & Tubes Div. . 249
Agency—Meldrum & Fewsmith, Inc.
Revere Copper & Brass, Inc. 8
Agency—St. Georges & Keyes, Inc.
Reynolds Metals Co. 50, 51
Agency—Price, Robinson & Frank, Inc.
Rogers Corp. 14
Agency—Charles Brunelle Co.
Rolock, Inc. 219
Agency—Edward W. Robotham & Co.
Ryerson, Joseph T., & Sons, Inc. 88
Agency—Aubrey, Finlay, Marley & Hodgson, Inc.

St. Joseph Lead Co. 32
Agency—Walter Taegen Associates
Sargeant & Wilbur, Inc. 236
Agency—Wells Advertising Agency
Saunders, Alexander, & Co. 261
Agency—Charles MacKenzie Advertising
Scott Testers, Inc. 236
Agency—Richard Thorndike Agency
Set Screw & Mfg. Co. 82
Agency—Van Auken, Ragland & Stevens
Sharon Steel Corp. 213
Sharon Steel Corp. 65
Agency—McClure & Wilder, Inc.
Shell Oil Co. 68
Agency—J. Walter Thompson Co.
South Chester Corp. 66
Agency—John P. Eldridge Advertising
Spencer Turbine Co. 229
Agency—Robert D. Towne Advertising
Sperry Products, Inc. 156
Agency—Hugh H. Graham & Associates
Stackpole Carbon Co. 158
Agency—Harry P. Bridge Co.
Standard Pressed Steel Co. 258
Agency—Gray & Rogers
Stanwood Corp. 220
Agency—Tri-State Advertising Co., Inc.
Stewart Industrial Furnace Div. 201
Agency—Perrin-Paus Co.
Stupakoff Ceramic & Mfg. Co. 227
Agency—Walker & Downing
Sunbeam Corp. 201
Agency—Perrin-Paus Co.
Superior Steel & Malleable Castings Co... 59
Agency—Paxson Advertising, Inc.
Superior Steel Corp. 69
Agency—Walker & Downing
Surface Combustion Corp. 161
Agency—Jay H. Maish Co.
Synthane Corp. 75
Agency—John Falkner Arndt & Co., Inc.

Teiner, Roland & Co., Inc. 170
Agency—Gordan Speedie Advertising
Tennessee Coal & Iron Div. 135, 136, 137, 138
Thiokol Corp. 40
Agency—John Gerber Advertising
Tickle, Arthur, Engineering Works 261
Agency—Harold Marshall Advertising Co.
Timken Roller Bearing Co., Steel & Tube Div. .....Back Cover
Agency—Batten, Barton, Durstine & Osborn, Inc.
Titanium Alloy Mfg. Div. 46
Agency—Comstock & Co.
Torrington Manufacturing Co. 238
Agency—Edward Graceman & Associates
Trent Tube Co. 163
Agency—G. M. Basford Co.
Tube Reducing Corp. 153
Agency—Michel-Cather, Inc.
Turner Halsey Co. 159
Agency—J. B. Rundle, Inc.

Union Carbide & Carbon Corp. 71, 86, 197, 231
United Chromium, Inc. 42
Agency—Rickard & Co., Inc.
United States Export Co.....135, 136, 137, 138
United States Gasket Co. 188
Agency—Michener Co.
United States Graphite Co. 15, 24, 25
Agency—Price, Hedrick & Tanner, Inc.
United States Rubber Co. 44, 70
Agency—Fletcher D. Richards, Inc.
United States Steel Co. 135, 136, 137, 138, 166
Agency—Batten, Barton, Durstine & Osborn, Inc.
United States Steel Supply Div. 135, 136, 137, 138, 166
Agency—Batten, Barton, Durstine & Osborn, Inc.
United States Testing Co., Inc. 257
Agency—Robert B. Grady Co.
Vanadium Corporation of America 199
Agency—Hazard Advertising Co.
Van der Horst Corp of America 171
Agency—G. Brayton Weider

Wales-Strippit Corp. 84
Agency—Horace A. Laney Advertising
Ward Leonard Electric Co. 208
Agency—James Thomas Chirurg Co.
Westinghouse Electric Corp. 157
Agency—Fuller & Smith & Ross, Inc.
Wheelco Instruments Div. 43
Agency—Hollingsworth & Collins
Whistler, S. B., & Sons, Inc. 160
Agency—Comstock & Co.
Wickwire Spencer Steel Div. 225
Agency—Doyle, Kitchen & McCormick, Inc.
Wiegand, Edwind L., Co. 221
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Wyman-Gordon Co. 181
Agency—John W. Odlin Co., Inc.

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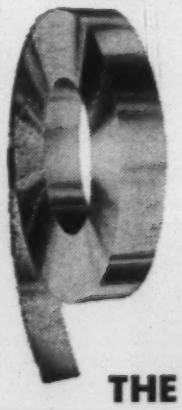

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The Editor's Page

A Materials Show

Elsewhere in this issue there are announcements of a new technical exposition to be held in New York next June. Regardless of its official title, we'll bet that it is soon known as the Materials Show. As we understand the aims, the new show will bring together under one roof most of the engineering materials now available to industry. Thus, comparisons can be made easily and promptly. Our big hope is that the show management will exclude those products which—although essential to industry—have little or nothing to do with the selection and application of materials and only tend to clutter up the premises. We can't help but wish the show success, for its aims appear to be parallel to our own, and that is to bring together in one place information on all engineering materials, not just metals, or plastics or ceramics or what-have-you.

Welcome Back

Sometime after this issue of M&M makes its appearance, we will welcome back to our editorial midst John B. Campbell, one of our associate editors who has been vacationing for the last two years in the Army. John renewed acquaintanceships and refreshed his memory at the recent Metal Show and now is raring to get back into action. When John gets back, our staff will be back up to full strength, and will be, in our unbiased opinion, one of the best technical magazine staffs now functioning.

A Milestone

Recently we distributed the 200,000th reprint copy of the MATERIALS & METHODS Manuals. This averages out to about 2300 copies of each of the 87 Manuals figuring in the tabulation. These, of course, are in addition to the magazine distribution, which has averaged nearly 20,000 a year over the period since 1944 when the Manual series started. The success-and-failure of certain Manuals proves how much instinct and intuition have to do with magazine editing. The proof is largely in the exception. By that we mean that some subjects, which seemed in advance prosaic and uninspiring, really excited reader interest. On the other hand, some glamor subjects laid eggs, as the comedians say.

All of that is fine, but we can't rest on our laurels. Thus, we have planned our Manual program for 1953 with the objective of making it of even more value to you.

Long Life

Usually, each issue of a magazine has a life span only slightly longer than that of each edition of a daily newspaper. However, there are some indications that this is not always true. For example, we recently received a communication asking if it would still be possible to obtain some manufacturers' literature described in the December 1944 issue of METALS AND ALLOYS. It wasn't.

Speaking of manufacturers' literature, perhaps an explanation is in order. Some readers believe we stock quantities of the bulletins described in the literature section. We don't carry any supply, but merely act as middleman to funnel your requests to the manufacturer. In this activity we handle requests for more than 8000 individual pieces of literature each month. We urge the manufacturers whose bulletins are sought to handle requests promptly, but we have no control over them.

Greetings

Before the page and the year both run out, I'd like to reserve this little spot to convey on behalf of the entire staff of M&M our sincere wishes for a Merry Christmas and a Happy, Peaceful and Fruitful New Year.

T. C. Du Mond
Editor

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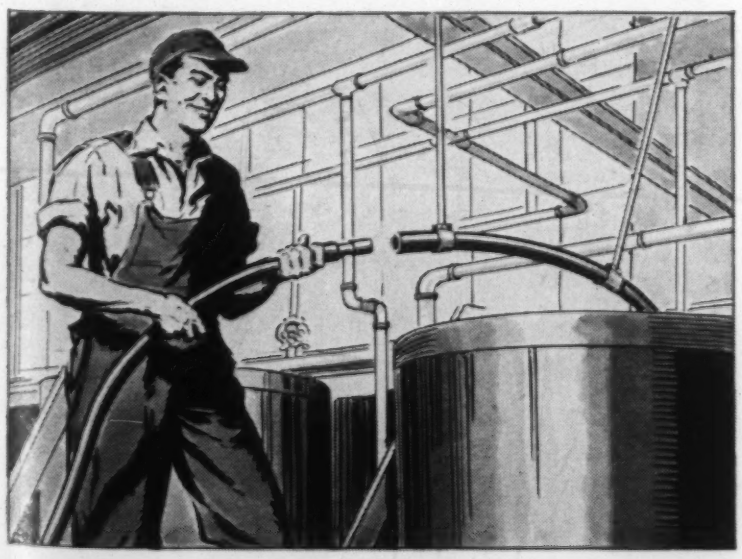

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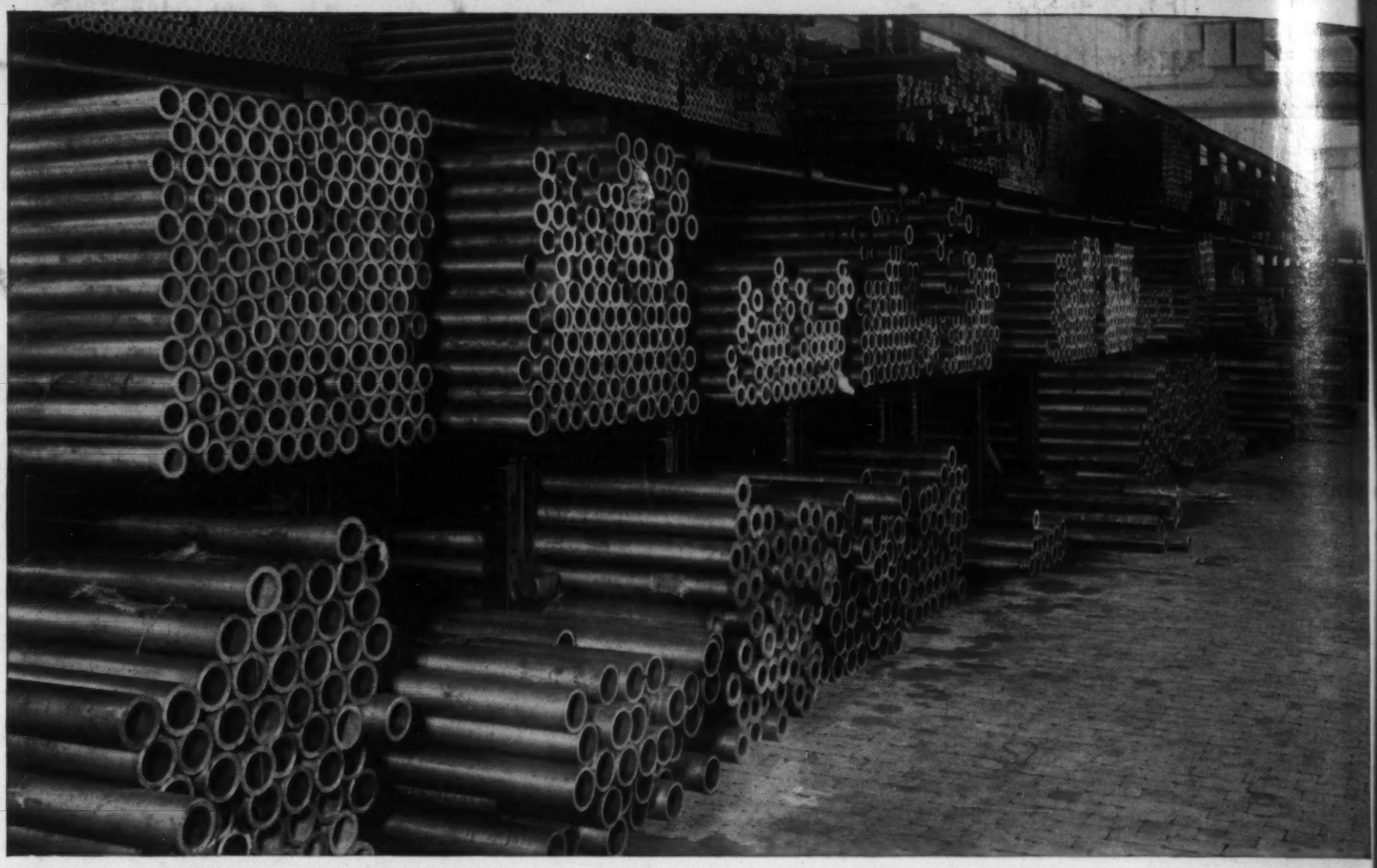

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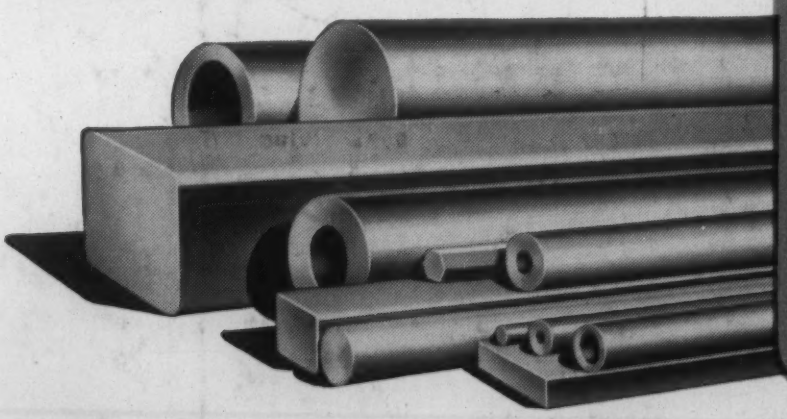

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